TO COMPARE THE EFFECT OF CLOSED KINEMATIC CHAIN EXERCISES WITH OPEN KINEMATIC CHAIN EXERCISES IN IMPROVING THE GLENOHUMERAL JOINT POSITION SENSE IN MALE CRICKET FAST BOWLERS

- A COMPARATIVE STUDY

Dissertation submitted to the Tamilnadu Dr. M.G.R. Medical University towards partial fulfillment of the requirements of **MASTER OF PHYSIOTHERAPY (Advanced PT in Orthopaedics) Degree Programme.**

KMCH COLLEGE OF PHYSIOTHERAPY

(A unit of Kovai Medical Centre Research and Educational Trust)

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2010-2012

CERTIFICATE

This is to certify that research work entitled **"TO COMPARE THE EFFECT OF OPEN KINEMATIC CHAIN EXERCISES WITH CLOSED KINEMATIC CHAIN EXERCISES IN IMPROVING THE GLENOHUMERAL JOINT POSITION SENSE IN MALE CRICKET FAST BOWLERS" – A COMPARATIVE STUDY** was carried out by the candidate bearing the Register No:27101601, KMCH College of Physiotherapy towards partial fulfillment of the requirements of the **Master of Physiotherapy (Advanced PT in Orthopaedics)** of the Tamil Nadu Dr. M.G.R. Medical University, Chennai-32.

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ABSTRACT

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Objectives

Cricket fast bowlers are having reduced glenohumeral joint Proprioception or joint position sense because of fatigue injuries. Proprioceptive training improves the joint position sense and there by reduces the risk of shoulder joint injuries. The aim of this study is to compare the effect of closed kinematic chain exercises with open kinematic chain exercises in improving the glenohumeral joint position sense in male cricket fast bowlers.

Study Design

A Pre test and post test experimental design.

Study Setting

KMCH college of Physiotherapy, Occupational therapy, S.N.R. college of arts and science, Jayendra college of arts and science Coimbatore.

Methodology

45 healthy male cricket fast bowlers are taken and they were divided into three groups by purposive sampling. Group A is closed kinematic chain group who receives pushups, bench press, wall press and stretching. Group B is open kinematic chain group who receives dumbbell exercises and stretching. Group C is control group who receives stretching alone. Outcome measures were glenohumeral joint position sense measured with inclinometer.

Results

Paired ‘t’ test and one way ANOVA were done and it was found that there was a significant difference between experimental groups and control group in improving the glenohumeral joint position sense. There is no statically significant difference found between the closed kinematic chain and open kinematic chain exercise groups in improving the gleno humeral joint position sense.

Conclusion

Our findings suggest that shoulder joint position sense can be enhanced by training with closed and open kinematic chain exercises which appear to be equally effective in improving shoulder joint position sense.

Key words; Joint position sense, Glenohumeral joint, Open kinematic chain exercises, Closed kinematic chain exercises.

INTRODUCTION

1.INTRODUCTION

Cricket is the most popular sport in India. It is played by many people in open spaces throughout the country though it is not the nation's official national sport. Cricket is a bat-and-ball game played between two teams with 11 players in each team on an oval-shaped field, at the centre of which is a rectangular 22-yard long pitch.

Fast bowling sometimes known as pace bowling is one of the main approaches to bowling in the sport of cricket. The fast bowlers can deliver the ball at a speed of over 90 miles per hour (140 km/h) and they sometimes rely on sheer speed to try and defeat the batsman, who is forced to react very quickly. Fast bowlers put extreme pressure on the whole body especially shoulder, feet and back.Fast bowlers are especially prone to injury as they perform their bowling technique at a very high intensity. However, fast bowlers have a high incidence of shoulder injuries, with 42% of the upper extremity Injuries.

Injuries in fast bowlers may be caused by a number of factors such as postural defects, poor bowling technique, inadequate physical or physiological attributes, as well as high physical demands. Fatigue is another most important reason which causes injury by decreasing the sensory motor system function. Even with a good bowling action overuse injuries can weaken the rotator cuff and allow the increased translational movement of the humeral head resulting in instability and shoulder pain[31 2].

The shoulder complex consists of 5 articulations in which the most important joint used by fast bowlers is the glenohumeral joint, which lacks bony stability and sacrifices the stability for increased mobility. Stability in the glenohumeral joint is provided by the glenohumeral ligaments, glenoid labarum, shoulder capsule and by the rotator cuff muscles. During bowling, the internal shoulder rotators are involved in the acceleration phase of the arm through concentric contractions, while the external rotators are involved during the deceleration phase. The presence of an imbalance between the agonist and antagonist is one of the major risk factors for developing shoulder injuries with deficiency in the external rotator strength possibly resulting in an injury[22 31].

The sensorimotor system is responsible for the body's coordination and stability and is a major component of function and performance in athletic activity. Proper function of the sensorimotor system is essential for injury-free athletics, especially with complex motor activities such as fast bowling. Functional fatigue decreases sensorimotor system function and may predispose the athlete to injury and also decreases the joint position sense acuity in athletes[3].

Proprioception is defined as a specialized variation of the sense of touch that encompasses the sensations of joint motion (kinaesthesia) and joint position (joint position sense).Since mechanoreceptors, which are responsible for proprioceptive feedback causing neuromuscular responses, are present in the musculature surrounding the joint, it is feasible to believe that, as a muscle fatigues, proprioceptive feedback is affected, and thereby, neuromuscular control and shoulder function are affected. Awareness of the body and its relationship with the surrounding environment is mediated by sensation. Sensation is the fundamental ingredient that mediates the proprioceptive mechanism[32].

A mounting body of evidence indicates that proprioceptive training can improve athletes' strength, coordination, muscular balance, and muscle-reaction times, and proprioceptive work also reduces the risk of injury during sporting activity and also boosts athletic performance. The most common training techniques used are Closed kinetic chain exercises, Open kinematic chain exercises, Plyometrics, Proprioceptive Neuromuscular Facilitation and sensorimotor rehabilitation.

Myers JB et al., suggested that proprioceptive and sensorimotor training program including closed kinematic shoulder exercises, plyometrics should be included as part of a shoulder rehabilitation or for prevention of injuries.

In open kinetic chain exercise, the terminal segment of the extremity moves freely without any external resistance. The sequential activation of muscles in open kinematic chain exercise from proximal to distal allows rapid acceleration and speed of the distal segment[15].

In closed kinetic chain exercise, the distal segment of the extremity is fixed, and proximal motion takes place in multiple planes. Closed kinetic chain exercise is thought to establish early proximal stability of the joint, providing a stable base for the upper extremity to function. A short fall of closed kinematic chain exercise is that minimal acceleration of the distal extremity is allowed, and this is a key component of upper extremity athletic performance[15].

1.1NEED FOR THE STUDY

One of the most common problems encountered in cricket fast bowlers is shoulder joint injuries. Fast bowlers with a front-on bowling action are more susceptible to an injury of the shoulder joint. Cricket fast bowlers are having reduced Proprioception or joint position sense because of fatigue injuries. There are so many studies done on cricket fast bowlers and Proprioception of back and knee joint but there are very few studies done on cricket fast bowlers and Glenohumeral joint position sense, so this study is to find out the effect of closed kinematic chain exercises with open kinematic chain exercises in improving the Glenohumeral joint position sense in cricket fast bowlers.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

2.1Proprioception

Sherrington in **1906** defined "Proprioception as the perception of the body, or body segments, in space". Generally divided into two elements: joint position sense and kinaesthesia[33].

Beard et al., (2005) described Proprioception as consisting of three elements:

1 A static awareness of joint position

2 Kinaesthetic awareness

3 A closed loop efferent reflex response required for regulation of muscle tone and activity.

2.2 Proprioceptors

Grays anatomy, 39 the edition chapter 1 pg 61 – 63 [14]

Receptor type	Location	Sensitive to	Activation threshold	Active when joint is	Response to persistent stimuli
Ruffini endings	Capsule and ligament	Joint position	Low	Static or dynamic	Slowly adapting
Pacinian corpuscles	Capsule and ligament	Acceleration or deceleration	Low	Dynamic only	Rapidly adapting
Golgi tendon organ	Ligament	Tension in ligaments, especially at end range of motion.	High	Dynamic only	Slowly adapting

2.3Mechanoreceptors

Marnie Allegrucci et al., (1995) said that joint receptors have a predominant role in proprioception and kinesthesia. Joint receptors have been identified in joint capsules, ligaments, labrum. The ruffini like endings in the gleno humeral joint capsule, pacinian corpuscles in glenohumeral ligaments and free nerve endings in the glenoid labrum. Joint receptors fire predominantly at the end range of motion. Contraction of muscles surrounding a joint can excite joint receptors but simulation can be induced only when the receptors are in proximity to the tendonous insertion of a given muscle[25].

Paul. A Borsa (1994) in his study said Mechanoreceptors are specialized neurons that transduce mechanical deformation into electrical signals concerning joint movement and position. three articular mechanoreceptors have been recently been identified in the glenoid labarum and glenohumeral ligaments suggesting that shoulder capsuloligamentous structures possess the anatomical basis for perceiving joint position and motion. ruffini endings and Golgi tendon organ like endings are slow adapting and are important in signalling actual joint position sense and change in joint position. pacinian corpuscles are rapidly adapting and function for the most part in sensing sudden motion or, acceleration or deceleration- type of motions .Stimulation of these receptors propagates the proprioceptive mechanism and results in proprioceptive sensibility and reflex muscular stabilization about the joint[28].

Martin Bjorklund (2006) stated in his study that the muscle spindles are regarded as important contributors to proprioceptive acuity[26].

2.4 Shoulder joint and Proprioception

Craig A. Wassinger et al., (2007) in his study he said that the shoulder joint has the greatest range of motion of any joint in the body, which potentially compromises its stability. As a result of this large range of motion, muscular coordination is vital to maintaining joint stability. Consequently, the shoulder relies upon proprioceptive feedback to maintain dynamic stability. Proprioception results from the integration of neural impulses from a variety of peripheral mechanoreceptors to the central nervous system. Mechanoreceptors are present in skin, muscle, and joint tissues and are activated by tissue deformation, which subsequently sends afferent neural impulses to the central nervous system, and are used for joint stability and proper joint function. The integrity of the mechanoreceptors and neural pathways plays a vital role in allowing shoulder mobility and concurrent stability[7].

2.5 Shoulder joint position sense

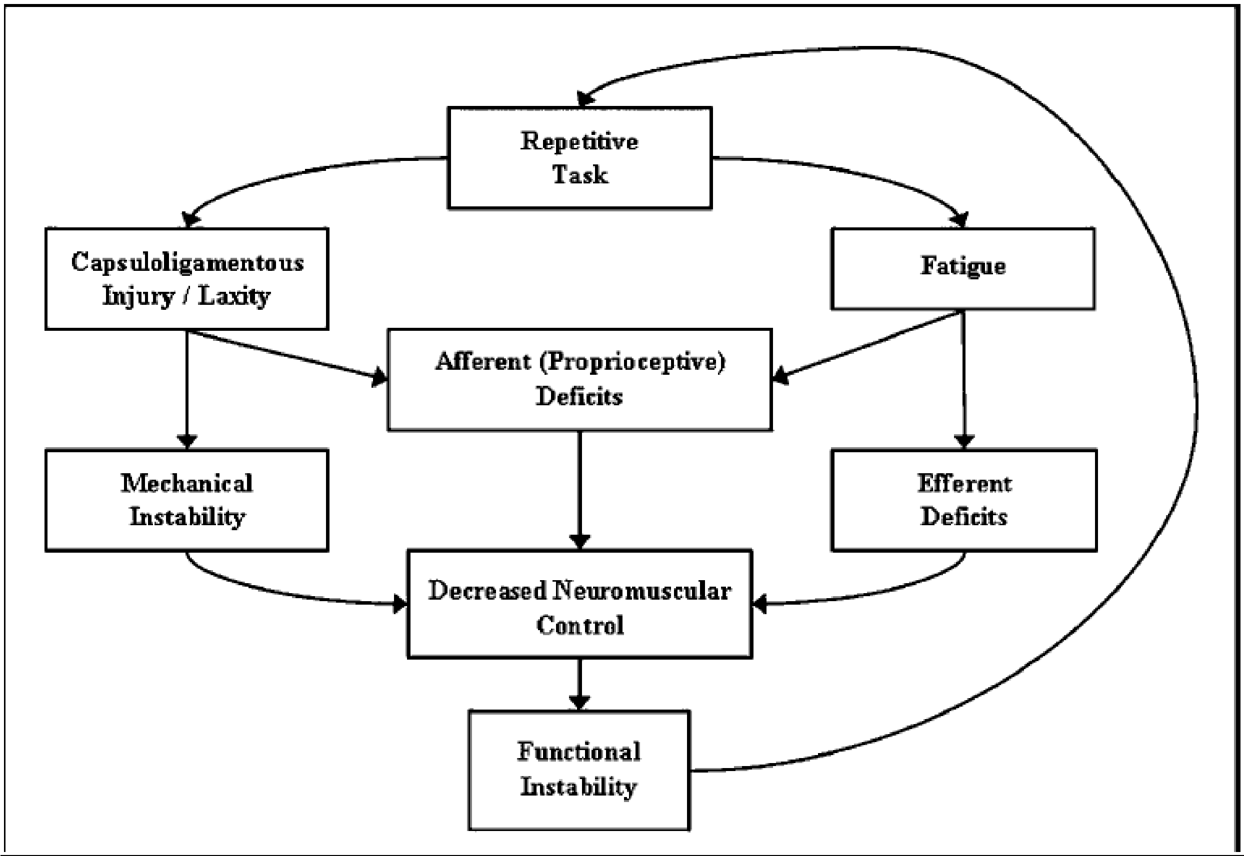
Jacqlyn Hyler et al., (1999) studied active joint position sense in dominant and non dominant shoulders in a group of six subjects (1 male, 5 females) and the results showed that there is a decrease in shoulder joint position sense in dominant shoulders compared with non dominant shoulders[18].

Brady L. Tripp et al., (2005) studied Functional Multijoint Position Reproduction Acuity in Overhead-Throwing Athletes in a group of Twenty-one male baseball players and concluded that Sensorimotor system in upper extremity function have focused on Proprioception, including kinaesthesia, joint position sense, and neuromuscular control (stability and balance). Declines in function of the sensorimotor system are associated with such acute and chronic upper extremity injuries in over headathletes[3].

Prawit Janwantanakul et al., (2001) studied Variation in Shoulder Position Sense at Mid and Extreme Range of Motion in 34 asymptomatic right handed men and concluded that Position sense acuity at the shoulder complex varied across the ROM and may be enhanced near the end of rotation range where there is more tension on the restraints to movement. Therefore, an individual's ROM should be factored into any attempt to assess or rehabilitate shoulder Proprioception[29].

2.6 Experimental evidences of fatigue induced proprioceptive deficits

Brady L Tripp et al., (2004.) studied functional fatigue reduces joint position sense in over head throwing athletes in a group of 13 subjects and measured active multijoint position reproduction accuracy in 3 dimensions using an electromagnetic tracking device. He concluded that Functional fatigue decreased joint position sense acuity in overhead-throwing athlete[4]



Joseph B. Myers et al., (1999) observed 32 physically active college students 16 males and 16 females, with no history of glenohumeral pathology, and concluded that Fatigue of the internal and external rotators of the shoulder decreased proprioception of the shoulder[20].

James E. Carpenter et al., (2003) studied the effect of muscle fatigue on shoulder joint position sense in 20 volunteers with no shoulder abnormalities and concluded that there is a decrease in proprioceptive sense with muscle fatigue which plays a major role in decreasing athletic performance[19]

Dylan Morrissey (2000) in his study said that Proprioception is a critical component of coordinated shoulder girdle movement with significant deficits having been identified in pathological and fatigued shoulders. It is an integral goal of rehabilitation programmes to attempt to minimize or reverse these proprioceptive deficits [9].

Brady L. Tripp et al., (2007) done a study on functional fatigue and upper extremity sensory motor system acuity in 16 baseball players and concluded that Functional fatigue affects the acuity of the entire upper extremity, each individual joint, and multiple joint motions in overhead throwers. Clinicians should consider the deleterious effects of upper extremity fatigue when designing injury prevention and rehabilitation programs and should incorporate multijoint and multiplanar endurance exercises. Compromised neuromuscular control of the scapulohumeral relationship may hold pathologic implications for this population as well[3].

2.7 Inclinometer

Geoffrey Dover et al., (2003) done a study on Reliability of Joint Position Sense and Force-Reproduction Measures During Internal and External Rotation of the Shoulder in 31 healthy subjects and proved that inclinometer can provide an affordable and accurate measure of joint position sense as same as an isokinetic dynamometer. The small, lightweight inclinometer generates no sound while operating and may provide less tactile feedback than other devices, so it may prove effective in measuring Joint position sense. He concluded that the inclinometer was found to be a reliable instrument as both inter-tester (.999) and intra-tester (.999) intra-class correlation coefficients were high[12].

Geoffrey C. Dover et al., (2003) assessed Joint position sense in 50 female softball players and 50 non throwing female athletes by using an inclinometer during four glenohumeral joint motions. Both the dominant and non dominant shoulders were assessed and error scores were calculated to describe joint position sense and concluded that there is decreased shoulder Proprioception in asymptomatic female athletes involved in over hand throwing sports, which may predispose them to injury[11].

Geoffrey Dover et al., (2004) done a study on joint position sense in 30 healthy subjects (15 men and 15 women) and he used inclinometer for assessing range of motion measurements and Joint angles and for testing joint position sense and he reported that inclinometer provides a very reliable and valid method of assessing joint position sense[13].

2.8 Evidences about open kinematic chain exercises and closed kinematic chain exercises in improving shoulder joint position sense

Scott. M . Lephart et al., (1994) done a study on Proprioception of the shoulder joint in healthy, unstable and surgically repaired shoulders in a group of 90 subjects and he measured both joint position sense and kinaesthesia. He concluded that the rehabilitation program will enhance Proprioception and it is given to emphasize proprioceptive input to recognize joint position and the learning of correct movement patterns and techniques. The exercises proposed by him are open kinemtic chain exercises, matching and rematching joint position, weight bearing exercises[34].

Edwin E. Bunton et al., (1993) studied The Role of Proprioception During Closed Kinetic Chain Rehabilitation and concluded that Closed kinetic chain rehabilitation exercises address the integration of proprioceptors, specifically Ruffini's endings, Pacinian corpuscles, Golgi- Mazzoni corpuscles, Golgi-Tendon Organs, Golgi-Ligament endings and muscle spindles. During rehabilitation, these receptors slowly adapt in that they continue to send impulses to the central nervous system as long as the neurological stimulus is present. A successful rehabilitation program must include activities that address the role of proprioceptors. The functional use of multiplanar movements used with closed kinetic chain exercises facilitates normal proprioceptive feedback[10].

Ian M. Rogol et al., (2011) done a study about Open and Closed Kinetic Chain Exercise on Shoulder Joint Reposition Sense in 39 healthy subjects with 13 in open kinematic group, 13 in closed kinematic group and 13 normal’s and concluded that shoulder joint reposition sense can be enhanced with training in healthy subjects. Also, open and closed kinetic chain exercises appear to be equally effective in improving shoulder joint reposition sense[16].

Andrade R, et al., (1998) done a study on co activation of arm and shoulder muscles during closed kinematic chain exercises in 20 healthy men and said that closed kinematic chain exercises promote an increased demand on the neuromuscular system to stabilize articular joints, increasing Proprioception, muscle control and muscle co activation[1].

2.9 Shoulder injuries in bowlers

R G Hackney (1996) studied on Advances in the understanding of throwing injuries of the shoulder and said that shoulder injuries are more common in throwing athletes. He said that the inferior glenohumeral ligament is the main static support of the shoulder in the abducted and externally rotated position. The range of motion in external rotation of the thrower's shoulder is extreme. The degree of laxity in the inferior glenohumeral ligament and other anterior structures necessary to permit such a range of motion in external rotation predisposes the athlete to anterior subluxation and instability. Supraspinatus pulls the humeral head into the glenoid as part of the rotator cuff. supraspinatus is most active in late cocking, when the shoulder is most susceptible to anterior translation and subluxation. Fatigue of supraspinatus leads to abnormal movement of the humeral head predisposing the shoulder to injury[32].

K D Aginsky et al., (2004) done a study on fast bowlers with in a group of 21 subjects and concluded that Shoulder injuries were more common in fast bowlers with a front-on action than the bowlers with a side-on or semi front-on action. Sixteen of the 21 fast bowlers showed low stability ratios compared with gravity corrected functional ratios, indicating an imbalance and the presence of possible dysfunction[23].

Rapheal Brandon et al., (1995) said that over head athletes involves in throwing action where the arm moves above the head the throwing movement recruits a large number of muscles and combines a large range of arm motion with high forces or speeds at the shoulder joint. All over head athletes tend to perform many repetitions of the movement usually with a dominant arm. For the shoulder and arm to move efficiently, requires coordinated movement of the scapula and humerus known as scapulohumeral rhythm. Scapular and humeral coordination also involves the stabilizing muscles of the scapula working in concert with the rotator cuff stabilizing muscles of the glenohumeral joint. If the scapula holds its position correctly the rotator cuff will do its job more effectively. If this mechanism is not proper then it puts excessive stress on the shoulder joint that leads to injury[30].

Roxanne Davies et al ., (2008) studied about Nature and incidence of fast-bowling injuries at an elite, junior level players in a group of 46 players and he concluded that the most common injuries were to the knee (41%) and lower back (37%), followed by shoulder injuries (16%)[31].

Kevin E. Wilk et al., (2002) done a study on base ball players and he stated that the overhead throwing motion is an extremely skilful and intricate movement that is very stressful on the shoulder joint complex. The overhead throwing athlete places extraordinary demands on this complex. Excessively high stresses are applied to the shoulder joint because of the tremendous forces generated by the thrower. The thrower's shoulder must be lax enough to allow excessive external rotation, but stable enough to prevent symptomatic humeral head subluxations, thus requiring a delicate balance between mobility and functional stability. They refer to this as the "thrower's paradox."This balance is frequently compromised, which leads to injury. The repetitive micro traumatic stresses placed on the athlete's shoulder joint complex during the throwing motion challenge the physiologic limits of the surrounding tissues. Frequently, alterations in throwing mechanics, muscle fatigue, muscle weakness or imbalance, and excessive capsular laxity may lead to tissue breakdown and injury[24].

Craig Ransona., (2008) done a study on one hundred and fifty eight professional cricket players and found out that twenty-three per cent of the participants described shoulder injury during the 2005 season. Sixty-four per cent of shoulder injured players often or always had associated problems when fielding and eighteen per cent of all participants felt pain on throwing at some stage during the study period[8].

2.10 Comparison between fast bowlers and spin bowlers

Gregory PL et al., compared the incidence of injuries of spin bowlers with fast bowlers with 42 spinners in group one and 70 fast bowlers in group two and he concluded that the incidence of injuries in fast bowling is greater than in spin bowling[15].

2.11 Proprioceptive training reduces the risk of injury

Irrgang, Chapter 7 in this they said that Proprioceptive or kinaesthetic sense through balance training enhances motor control, which is needed to decrease the risk of injury or re-injury during practice or competition. When injury to a joint or musculo-tendinous structure occurs, somato-sensory information is altered, adversely affecting motor control. Hence, rehabilitation should emphasis restoring the athlete's balance strategies. This will also decrease the risk of recurrent injury[17].

2.12 Proprioception training improves athletes performance

Joseph B. Myers (2009) done a study on sensorimotor training in shoulder injury and concluded that the sensorimotor system contributes to joint stability and function through its control over the muscles that cross the shoulder joint complex. Injury, pain, and fatigue to the shoulder can affect the sensorimotor system both centrally and peripherally due to tissue trauma, pain, and stretching of the tissues, resulting in decreased stability and function. Given the important role the sensorimotor system plays in joint stability and function and how the sensorimotor system is affected by the joint injury. Training of the sensorimotor system is crucial in treatment following injuries. As such, clinicians should include sensorimotor training components in their rehabilitation following injury given the deficits that are present with injury and pain, or as part of their prevention programs to reduce the effects of fatigue on the sensorimotor system[21].

2.13 Six weeks training

Kathleen R. Lust, (2007) done a study on The Effects of a Six Week Open Kinetic Chain/Closed Kinetic Chain and Open Kinetic Chain/Closed Kinetic Chain/Core Stability Strengthening Program in 19 Baseball players and concluded that there is a statistical significance from pre-test to post-test results for the Functional Throwing Performance Index, and Closed Kinetic Chain Upper Extremity Stability Test within subjects main effects. Although pre-test to post-test results were not significant for between group main effects ,it is apparent that those participating in the experimental groups demonstrated improved testing scores from pre-test to post-test and he said that these exercises would be performed on individuals with upper extremity injuries, which should result in a greater improvement of strength, endurance, and Proprioception of the shoulder joint repositioning in those throwing athletes[22].

Ian M. Rogol et al., (1998) done a study on effect of open kinematic chain exercises with closed kinematic chain exercises in improving joint position sense in 39 healthy subjects and they all participated in the training program for 6 weeks. The subjects assigned to the Closed kinematic training group performed 3 sets of 15 repetitions of standard push-ups 3 days per week. The subjects in the open kinematic chain group performed 3 sets of 15 repetitions of the supine dumbbell press 3 days per week and he concluded that open and closed kinematic chain exercises are equally affective in improving shoulder joint position sense[16].

AIM AND OBJECTIVES

3. AIM AND OBJECTIVES

3.1 AIM OF THE STUDY

To evaluate the effect of closed kinematic chain exercises with open kinematic chain exercises in improving the glenohumeral joint position sense in male cricket fast bowlers.

3.2 OBJECTIVES OF THE STUDY

To find out the effect of closed kinematic chain exercises in improving the glenohumeral joint position sense in male cricket fast bowlers.

To find out the effect of open kinematic chain exercises in improving the glenohumeral joint position sense in male cricket fast bowlers.

To compare the effect of closed kinematic chain exercises with open kinematic chain exercises in improving the glenohumeral joint position sense in male cricket fast bowlers.

To prevent the injuries in bowlers.

MATERIALS &METHODOLOGY

4. MATERIALS AND METHODOLOGY

4.1 STUDY DESIGN

A Pre test and post test experimental design.

4.2 SAMPLING TECHNIQUE

Purposive sampling technique.

4.3 STUDY POPULATION

45 healthy male cricket fast bowlers were selected and divided into three groups with 15 in each group.

4.4 STUDY SETTING

KMCH college of Physiotherapy, Occupational therapy, S.N.R. college of arts and science, Jayendra college of arts and science.

4.5 STUDY DURATION

Six months

4.6 TREATMENT DURATION

Six weeks

4.7 INCLUSION CRITERIA

Dominant arm cricket fast bowlers

Age 18 to 25 years

Sex : male

Regular practicing of three times a week.

4.8 EXCLUSION CRITERIA

Age below 18 years and above 25 years.

Any neurological diseases.

Any cardiovascular problems.

Previous shoulder dislocations.

Previous shoulder surgeries.

Any tumors in the shoulder region, cervical region.

Previous shoulder injuries and shoulder pain.

Spin and medium pace bowlers.

4.9 MEASUREMENT TOOL

Inclinometer for measuring glenohumeral joint position sense.

4.10 OUTCOME MEASURES

Glenohumeral joint position sense.

4.11NULL HYPOTHESIS

H_{01} There is no significant improvement in glenohumeral joint position sense with closed kinematic chain exercises in male cricket fast bowlers.

H_{02} There is no significant improvement in glenohumeral joint position sense with open kinematic chain exercises in male cricket fast bowlers.

H_{03} There is no significant improvement in glenohumeral joint position sense with control group.

H_{04} There will be no significant difference in glenohumeral joint position sense comparing closed with open kinematic chain exercises with control group in male cricket fast bowlers.

4.12ALTERNATE HYPOTHESIS

H_{A1}There is significant improvement in glenohumeral joint position sense with closed kinematic chain exercises in male cricket fast bowlers.

H_{A2}There is significant improvement in glenohumeral joint position sense with open kinematic chain exercises in male cricket fast bowlers.

H_{A3} There is significant improvement in glenohumeral joint position sense with control group.

H_{A4} There is significant difference in glenohumeral joint position sense comparing closed with open kinematic chain exercises with control group in male cricket fast bowlers.

4.13 STUDY METHOD

The subjects were divided into three groups Group- A, Group- B and Group – C.

Group-A (closed kinematic chain exercise group)

closed kinematic chain exercises 3sets of 15 repetitions [5 days per week] and stretching were given.

Group-B (open kinematic chain exercise group)

open kinematic chain exercises, 3 sets of 15 repetitions [5 days per week] and stretching were given.

Group-C (control group)

control group (only stretching).

4.14PROCEDURE

ASSESSMENT PHASE

Fast bowlers were taken into the study with the help of coach. The subjects were given an informed consent which the bowlers read and if they agreed to take part in the study, they were assigned to either the open kinematic exercise group or closed kinematic chain exercise group or conventional group using a purposive sampling technique .

Joint position sense testing will be performed with the subject in the standing position. To begin the test the examiner will securely attach the inclinometer to the subject's wrist using straps. The subjects were asked to remove the shirt and also they are blindfolded to eliminate any tactile and visual cues.

Range of motion will be assessed in three criterion positions for both external rotation and internal rotation that is 15 degrees, 30 degrees and 45 degrees of each individual's shoulder rotation range with shoulder in 90 degrees of abduction and elbow in 90 degrees of flexion.

With the inclinometer in 0 degrees ask the subject to maintain the above position and ask him to move the arm into internal rotation position actively. When the subject reaches the 15 degrees angle then the examiner will ask the person to stop and hold it for 3 seconds and then the examiner will bring back the arm to the starting position and the subject will be immediately instructed to bring back the arm to the target angle and ask him to stop and inform when he felt the position has been achieved.

At that time record the angle observed in the inclinometer. The measurements will be repeated two more times for a total of three trails with a thirty second rest period separating the trials. Then calculate the target angles achieved by the subject. Repeat the above procedure for 30 degrees and 45 degrees of internal rotation and 15, 30 and 45 degrees of external rotation.

TRAINING PHASE

GROUP-A

The subjects assigned to the Closed kinematic chain exercises performed5 repetition of self-stretching exercise to shoulder internal and external rotator muscles followed by 3 sets of 15 repetitions of standard push ups and wall push ups and bench press ups, 5 days per week for six weeks.

GROUP-B

The subjects assigned to the open kinematic chain exercises performed 5 repetition of self-stretching exercise to shoulder internal and external rotator muscles followed by 3 sets of 15 repetitions of standard 3 Kg weight dumbbell exercises, 5 days per week for six weeks.

GROUP- C

The subjects assigned to control group performed 5 repetition of self-stretching exercise to shoulder internal and external rotator muscles.

4.15 PHOTOGRAPHIC ILLUSTRATION

4.15.1Exercises for open kinematic chain exercise group

(A)

(B)

Dumbbell exercises for (A) Internal rotators (B) External rotators and (C) In Scaption

4.15.2 Exercises for Closed Kinematic Chain exercise group

PUSH UPS

(A)

(B)

WALL PUSH UPS

(A)

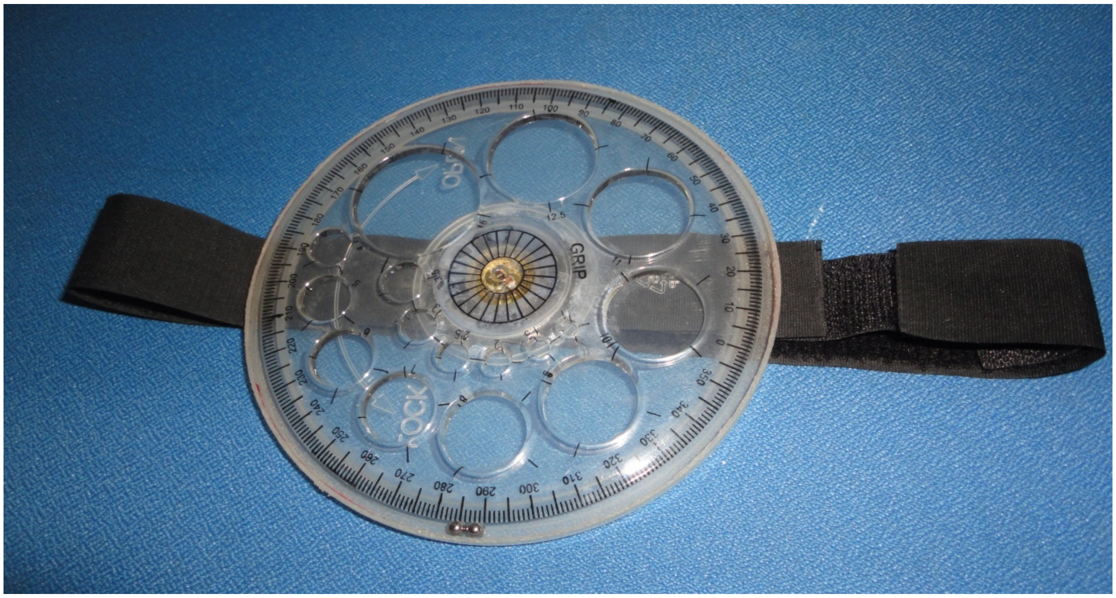
(B)

BENCH PRESS UPS

(A)

(B)

INCLINOMETER



(A)

(B)

4.16 STATISTICAL ANALYSIS

4.16.1 PAIRED 't' TEST (within groups)

It is used to find out the significance of the mean of difference between the three related samples and the calculated t- value is compared with table t- distribution (for 5% level of significance) to the given degree of freedom. If t- value equals or exceeds the t- distribution value, then we can say that there is a significant difference between the sample mean.

$$t = \frac{\bar{d}\sqrt{n}}{S}$$

substitute s in the formula,

$$S = \sqrt{\frac{\sum \boldsymbol{d^2} - \left[\bar{\boldsymbol{d}}\right]^2 \times \boldsymbol{n}}{\boldsymbol{n-1}}}$$

X 1 - Pre- test value

X2 - post test value

d - X2 – X

S - combined standard deviation

d_1, d_2&d_3 -difference between initial & final readings in 3groups respectively. n_1,n_2&n_3 - number of patients in 3groups respectively.

4.16.2 ONE WAY ANOVA

Source of variation	Sum of square (SS)	Degrees of freedom	Mean squares (MS)	F-ratio
Between samples	$n_1 (x_1 - x)^2 + \ldots$ $n_k(x_k - x)^2 + \ldots$	$k – 1$	$\frac{\text{SS between}}{k - 1}$	$\frac{\text{MS between}}{\text{MS within}}$
Within samples	$\Sigma(x_1 – x_1)^2 + \ldots$ $\Sigma(x_k – x_k)^2 + \ldots$	$n – k$	$\frac{\text{SS within}}{n - k}$	

F= MSC/ MSE

Where,

F= Fischers test

MSC= mean sum of square between column

MSE= mean sum of square with in column.

DATA PRESENTATION

5. DATA PRESENTATION

5.1 PAIRED‘t’ TEST

5.1.1 Comparison on closed kinematic chain exercise group

Group	Range of motion	Pre-test	Post-test	Paired – T value	Table – T value
	Internal Rotation	Mean in Degrees			
Closed	15^0	6.4800	2.0867	10.742	
Closed	30^0	8.0067	2.6200	9.446	
Closed	45^0	6.5733	2.1200	11.455	2.145
	External Rotation	Mean in Degrees			
Closed	15^0	6.3733	2.0867	9.937	
Closed	30^0	7.5733	2.4400	9.609	
Closed	45^0	7.7333	2.3067	11.963	

Fig 5.1 Paired t- test at 15^0 internal rotation for closed kinematic group

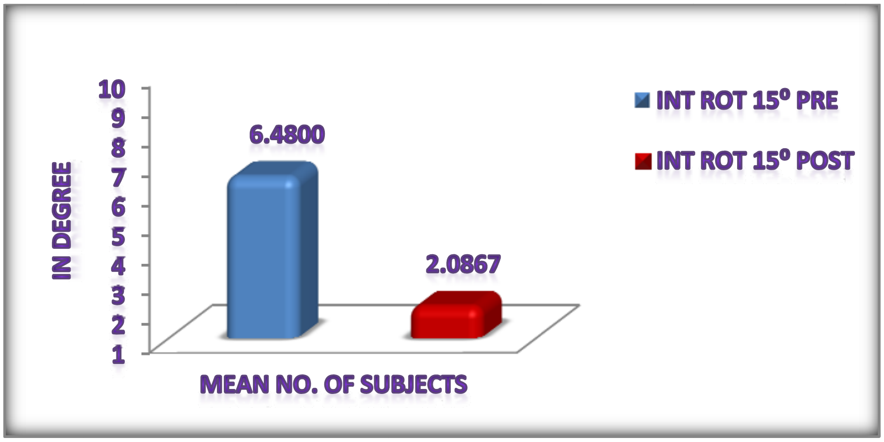


Fig 5.2 Paired t- test at 30^0 internal rotation for closed kinematic group

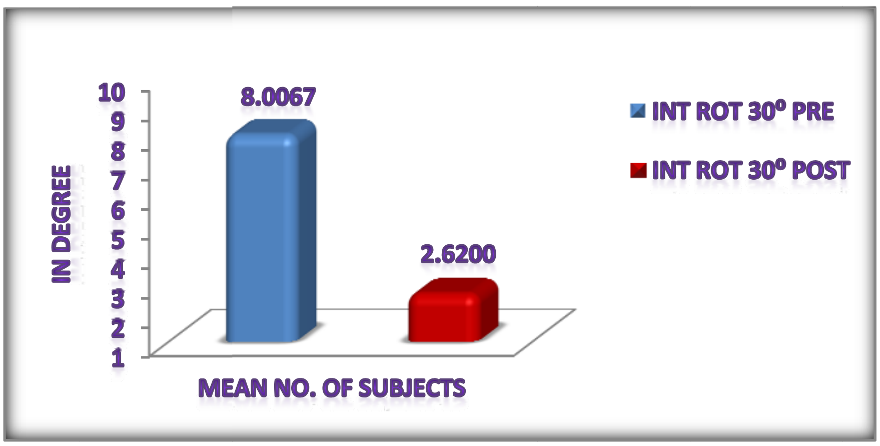


Fig 5.3 Paired t- test at 45^0 internal rotation for closed kinematic group

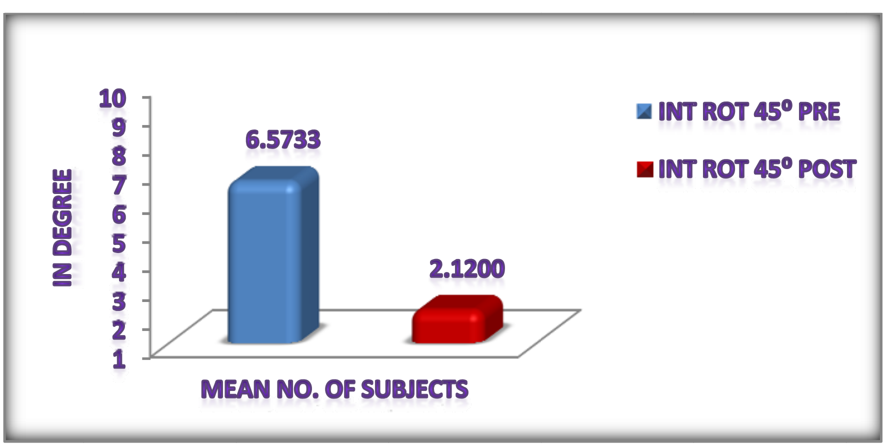


Fig 5.4 Paired t- test at 15^0 external rotation for closed kinematic group

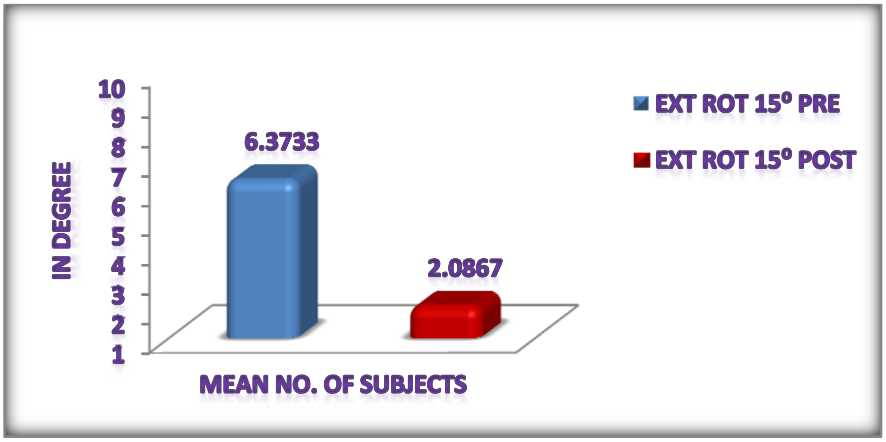


Fig 5.5 Paired t- test at 30^0 external rotation for closed kinematic group

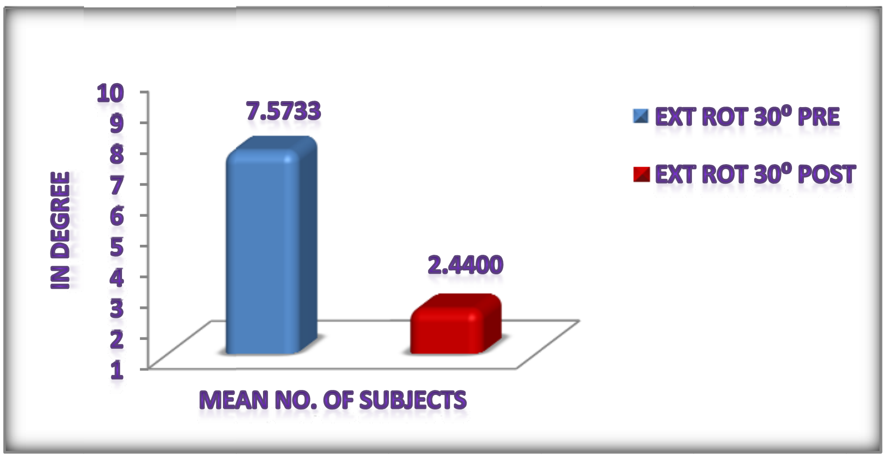
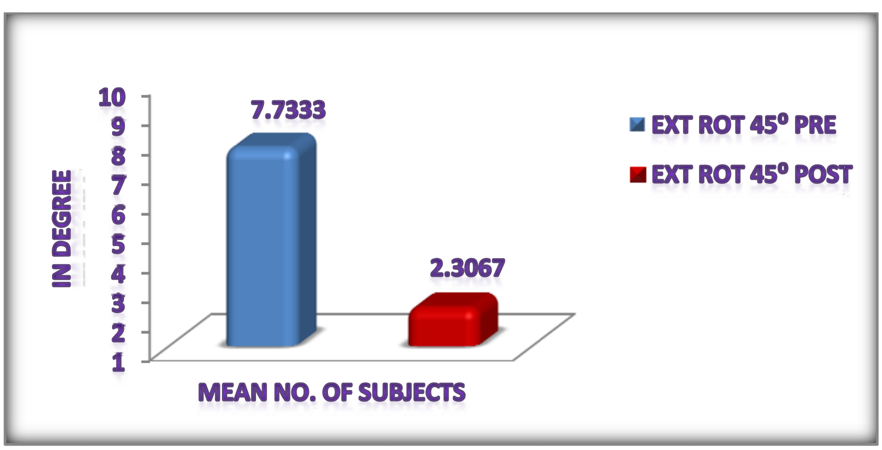


Fig 5.6 Paired t- test at 45^0 external rotation for closed kinematic group



5.1.2 Comparison on open kinematic chain exercise group

Group	Range of motion	pre-test	Post-test	Paired – T value	Table – T value
	Internal rotation	Mean in degrees			2.145
Open	15^0	6.6133	2.6667	14.838	
Open	30^0	8.2600	3.1200	7.450	
Open	45^0	6.3600	2.8800	10.905	
	External rotation	Mean in degrees			
Open	15^0	6.8200	2.8800	10.428	
Open	30^0	8.1467	3.0133	7.265	
Open	45^0	10.0333	3.0133	16.805	

Fig 5.7 Paired t- test at 15^0 internal rotation for open kinematic group

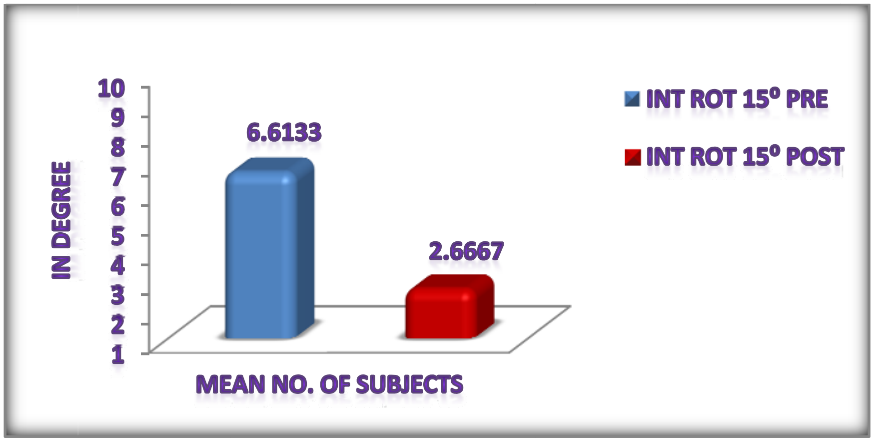


Fig 5.8 Paired t- test at 30^0 internal rotation for open kinematic group

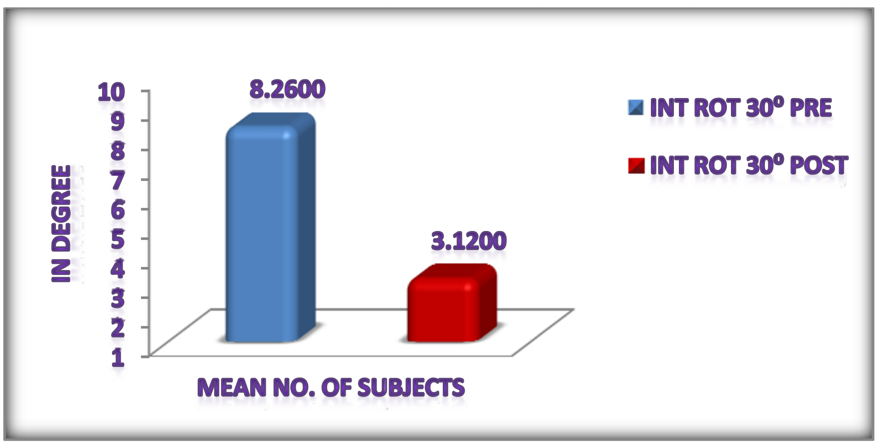


Fig 5.9 Paired t- test at 45^0 internal rotation for open kinematic group

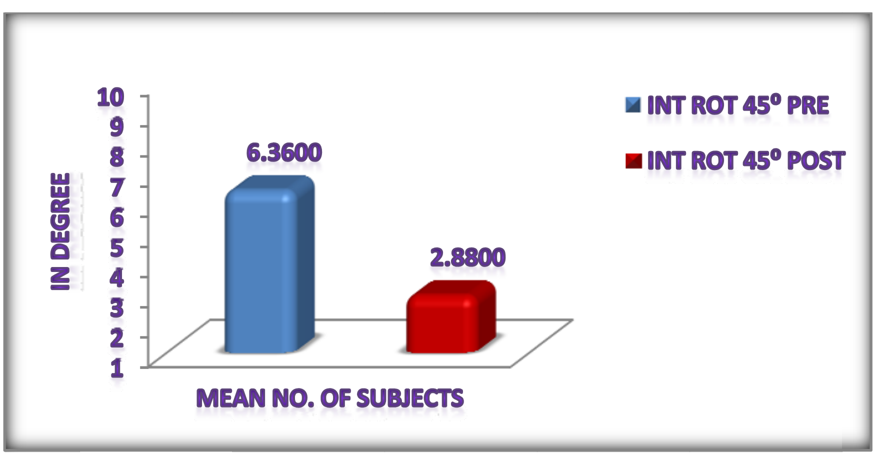


Fig 5.10 Paired t- test at 15^0 external rotation for open kinematic group

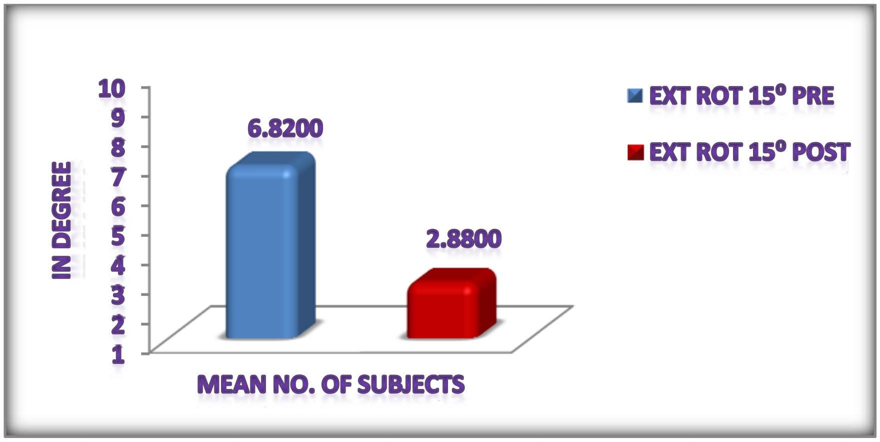


Fig 5.11 Paired t- test at 30^0 external rotation for open kinematic group

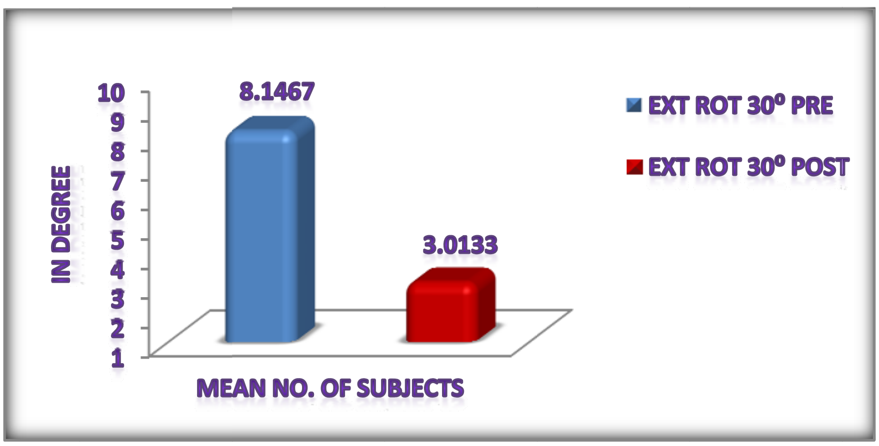
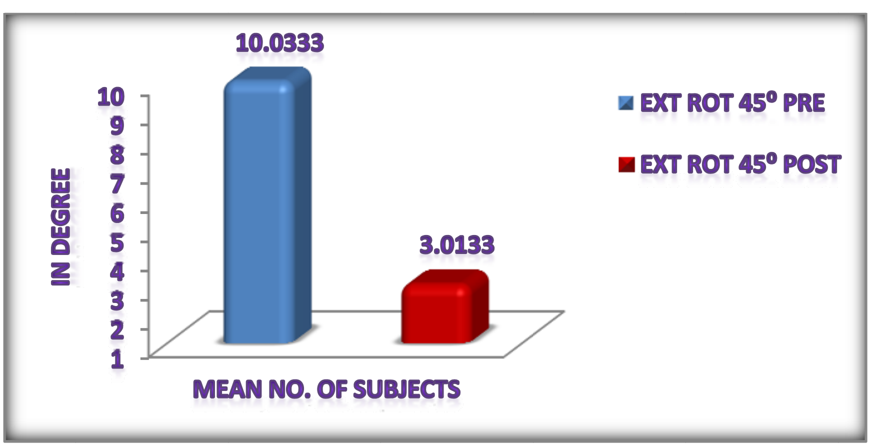


Fig 5.12 Paired t- test at 45^0 external rotation for open kinematic group



5.1.3Comparison on control group

Group	Range of motion	Pre-test	Post-test	Paired – T value	Table – T value
	Internal rotation	Mean in degrees			2.145
Control	15^0	6.4400	4.7267	9.191	
Control	30^0	8.8133	6.8867	4.789	
Control	45^0	6.6000	5.5600	4.801	
	External rotation	Mean in degrees			
Control	15^0	6.5000	5.1000	4.692	
Control	30^0	8.3867	6.7467	7.696	
Control	45^0	7.9133	6.0200	9.659	

Fig 5.13 Paired t- test at 15^0 internal rotation for control group

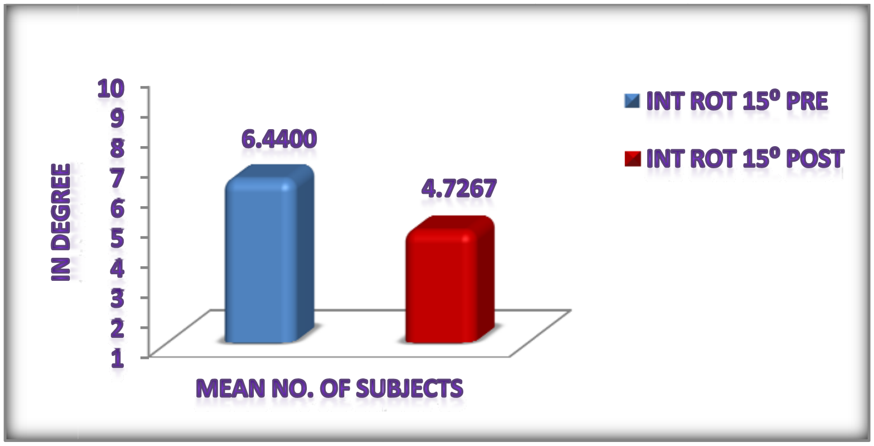


Fig 5.14 Paired t- test at 30^0 internal rotation for control group

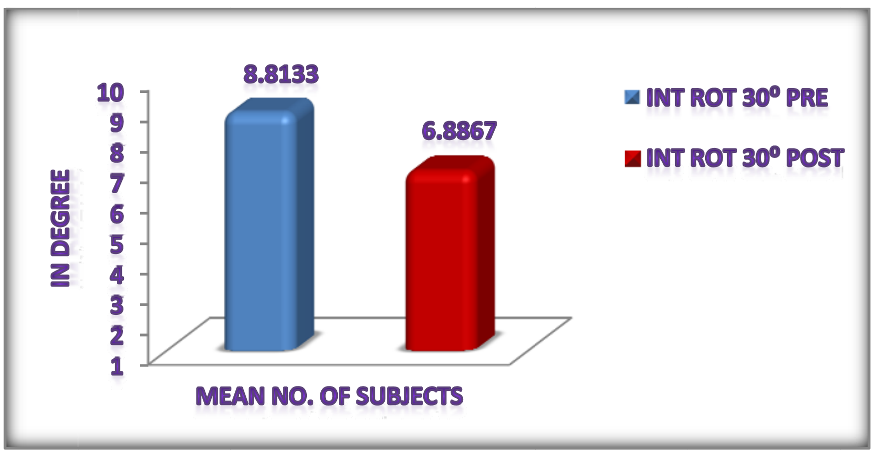


Fig 5.15 Paired t- test at 45^0 internal rotation for control group

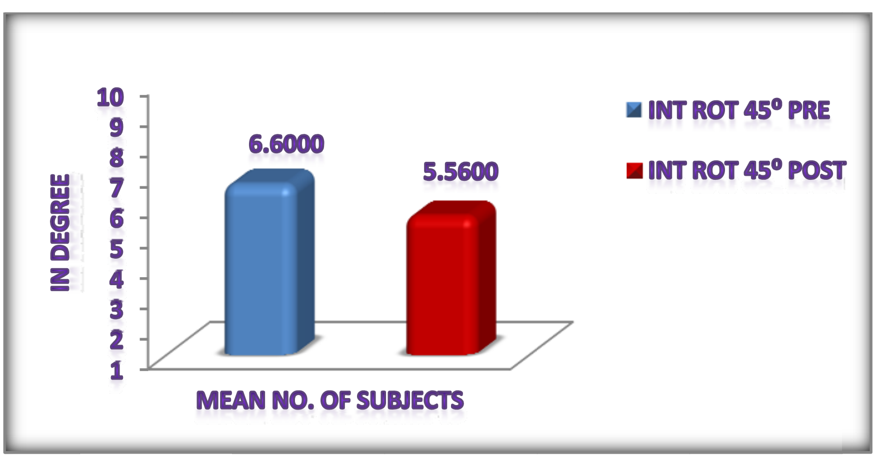


Fig 5.16 Paired t- test at 15^0 external rotation for control group

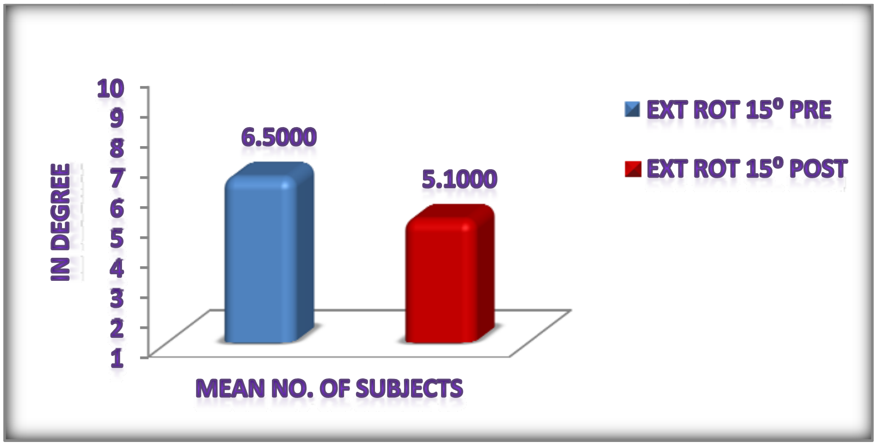


Fig 5.17 Paired t- test at 30^0 internal rotation for control group

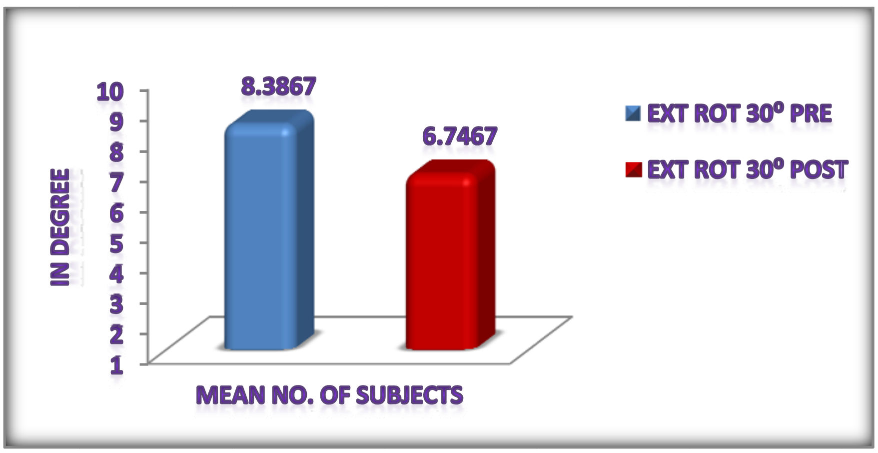
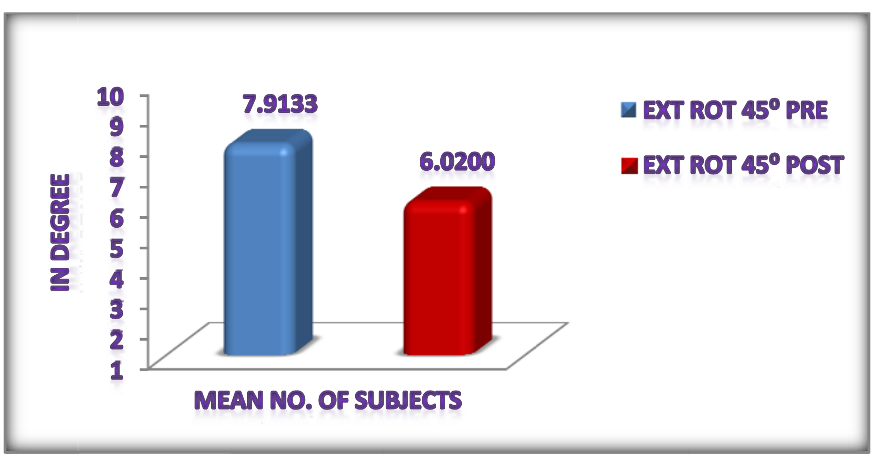


Fig 5.18 Paired t- test at 45^0 external rotation for control group



5.2 ANOVA

5.2.1 PRE TEST 15^0 INTERNAL ROTATION

Source of variation	Sum of squares (SS)	Degrees of freedom	Mean squares (MS)	Calculated F – ratio	Table F- ratio
Between samples	.247	2	.124	.065	4.98
Within samples	79.737	42	1.899		

5.2.2 POST TEST 15^0 INTERNAL ROTATION

Source of variation	Sum of squares (SS)	Degrees of freedom	Mean squares (MS)	Calculated F – ratio	Table F- ratio
Between samples	57.748	2	28.874	49.783	4.98
Within samples	24.360	42	.580		

Fig 5.19 Mean pre-test values of groups A, B, and C at 15^0 of internal rotation

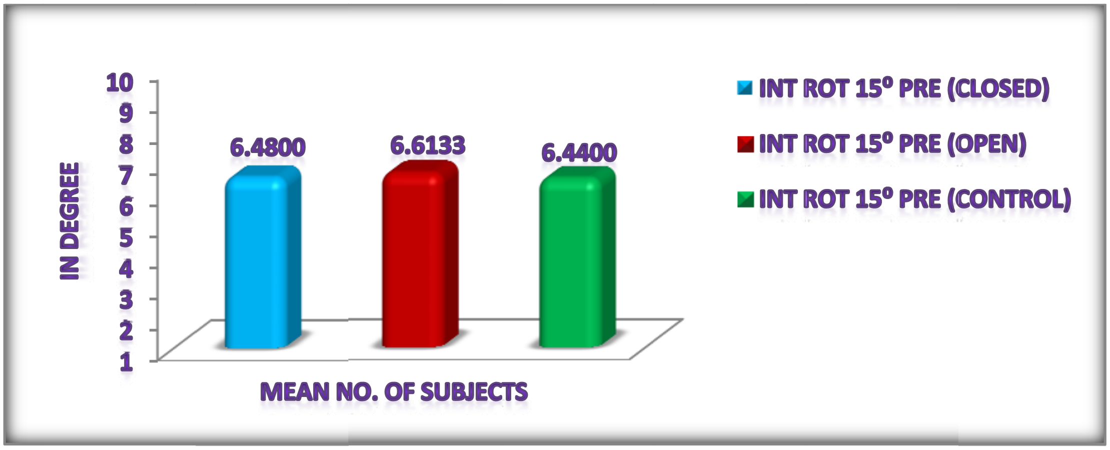


Fig 5.20 Mean post test values of groups A, B, and C at 15^0 of internal rotation

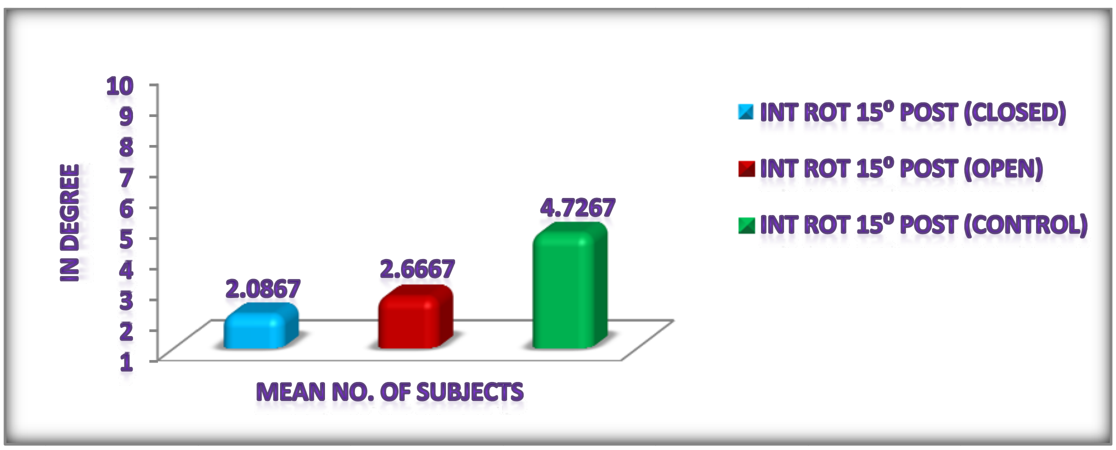
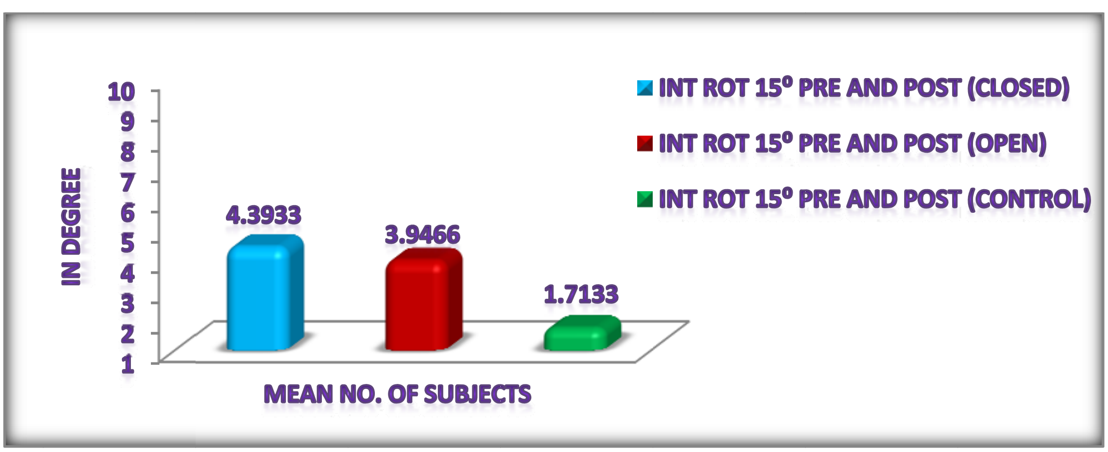


Fig 5.21 Comparison of mean improvement at 15^0 of internal rotation



5.2.3PRE TEST 30^0 INTERNAL ROTATION

Source of variation	Sum of squares (SS)	Degrees of freedom	Mean squares (MS)	Calculated F – ratio	Table F- ratio
Between samples	5.105	2	2.553	.419	4.98
Within samples	255.923	42	6.093		

5.2.4 POST TEST 30^0 INTERNAL ROTATION

Source of variation	Sum of squares (SS)	Degrees of freedom	Mean squares (MS)	Calculated F – ratio	Table F- ratio
Between samples	163.211	2	81.606	87.023	4.98
Within samples	39.385	42	.938		

Fig 5.22 Mean pre-test values of groups A, B, and C at 30^0 of internal rotation

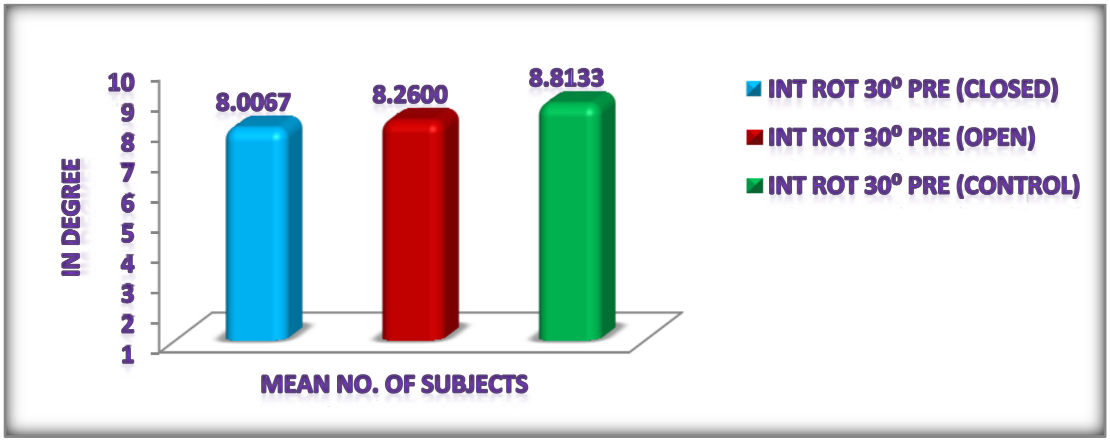


Fig 5.23 Mean post test values of groups A, B, and C at 30^0 of internal rotation

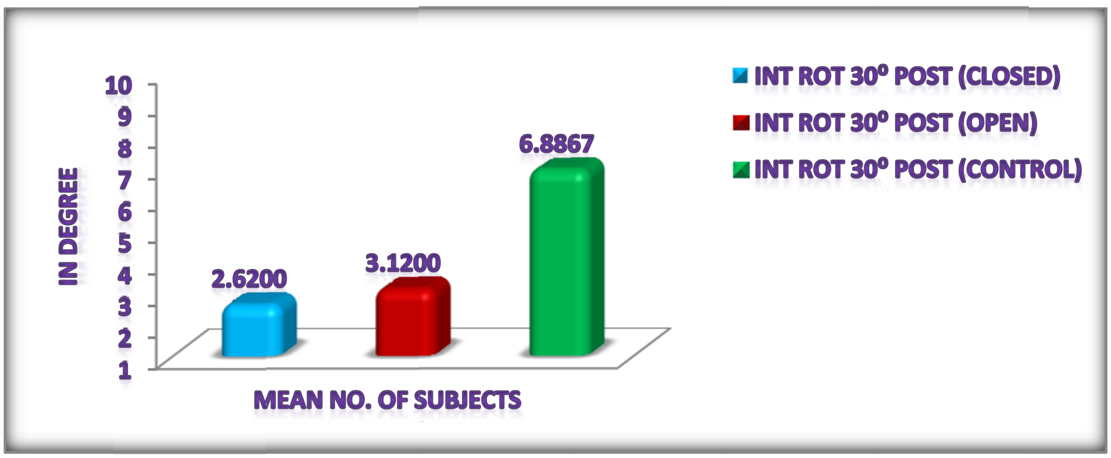
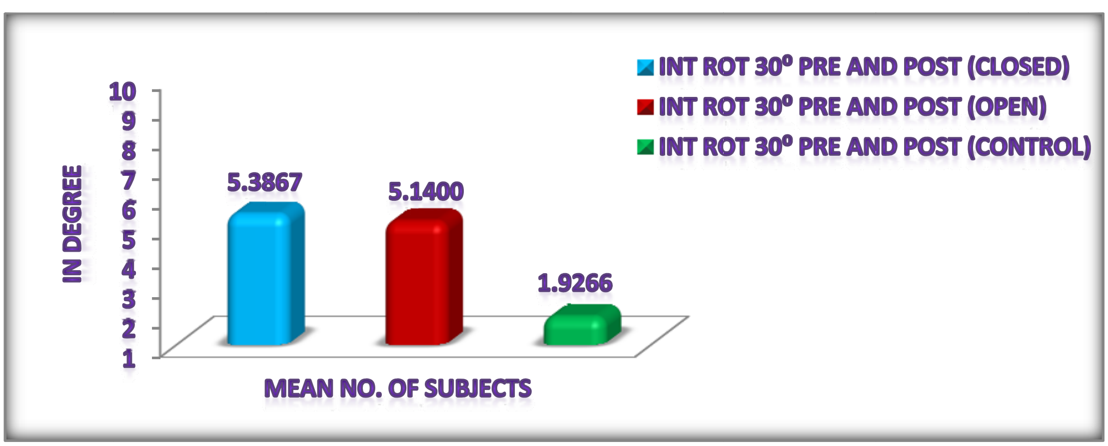


Fig 5.24 Comparison of mean improvement at 30^0 of internal rotation



5.2.5PRE TEST 45^0 INTERNAL ROTATION

Source of variation	Sum of squares (SS)	Degrees of freedom	Mean squares (MS)	Calculated F – ratio	Table F- ratio
Between samples	.519	2	.260	.144	4.98
Within samples	75.445	42	1.796		

5.2.6 POST TEST 45^0 INTERNAL ROTATION

Source of variation	Sum of squares (SS)	Degrees of freedom	Mean squares (MS)	Calculated F – ratio	Table F- ratio
Between samples	97.968	2	48.984	54.944	4.98
Within samples	37.444	42	.892		

Fig 5.25 Mean pre-test values of groups A, B, and C at 45^0 of internal rotation

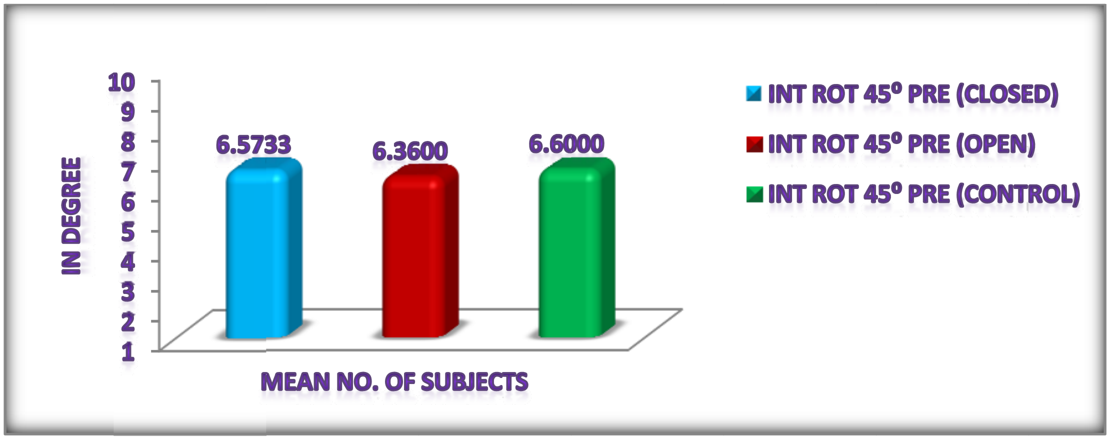


Fig 5.26 Mean post test values of groups A, B, and C at 45^0 of internal rotation

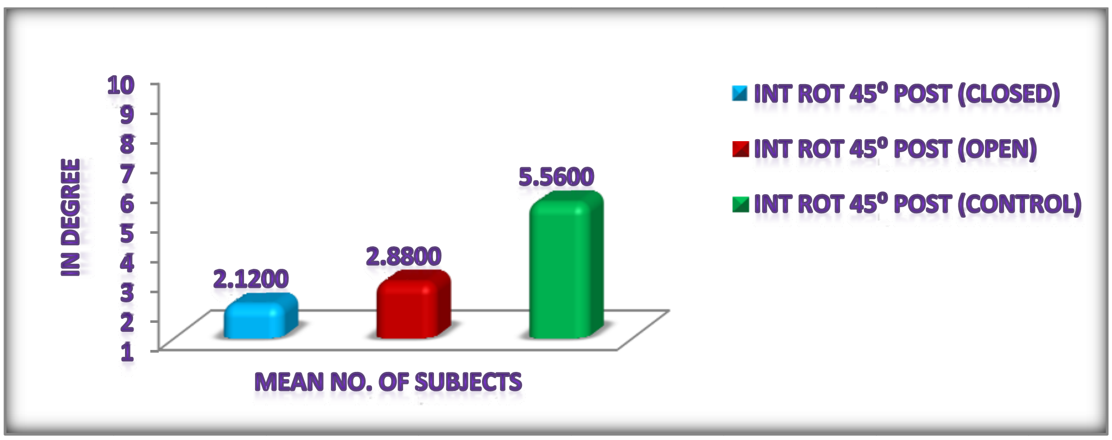
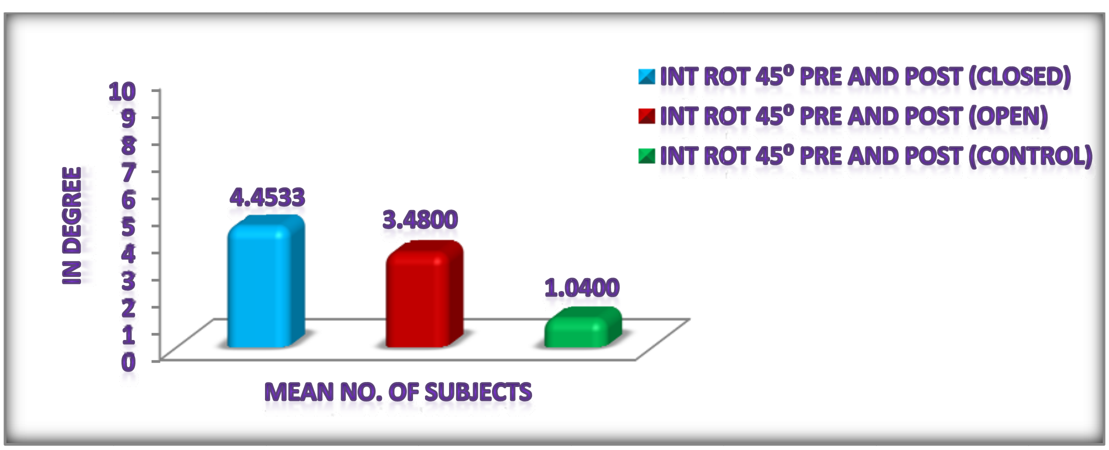


Fig 5.27 Comparison of mean improvement at 45^0 of internal rotation



5.2.7 PRE TEST 15^0 EXTERNAL ROTATION

Source of variation	Sum of squares (SS)	Degrees of freedom	Mean squares (MS)	Calculated F – ratio	Table F- ratio
Between samples	1.590	2	.795	.302	4.98
Within samples	110.653	42	2.635		

5.2.8 POST TEST 15^0 EXTERNAL ROTATION

Source of variation	Sum of squares (SS)	Degrees of freedom	Mean squares (MS)	Calculated F – ratio	Table F- ratio
Between samples	73.190	2	36.595	32.659	4.98
Within samples	47.061	42	1.121		

Fig 5.28Mean pre-test values of groups A, B, and C at 15^0 of external rotation

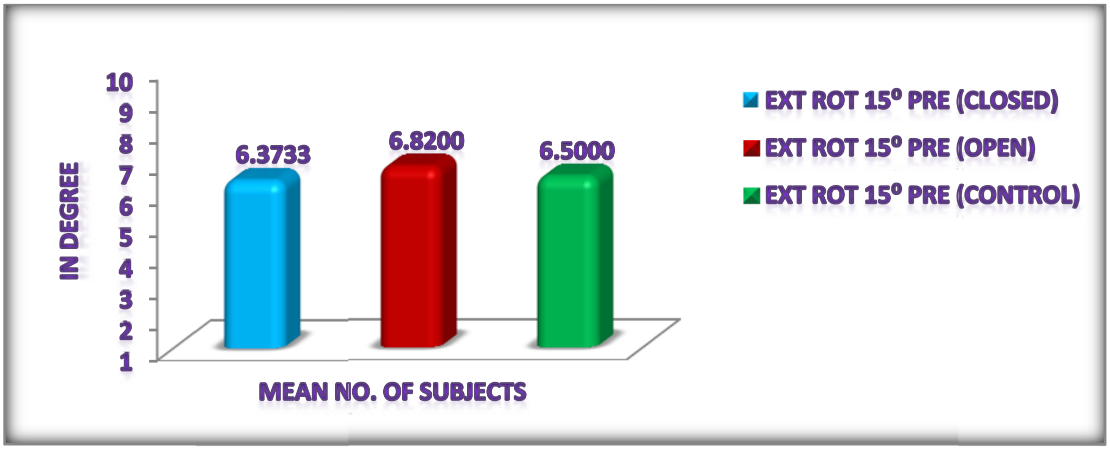


Fig 5.29Mean post test values of groups A, B, and C at 15^0 of external rotation

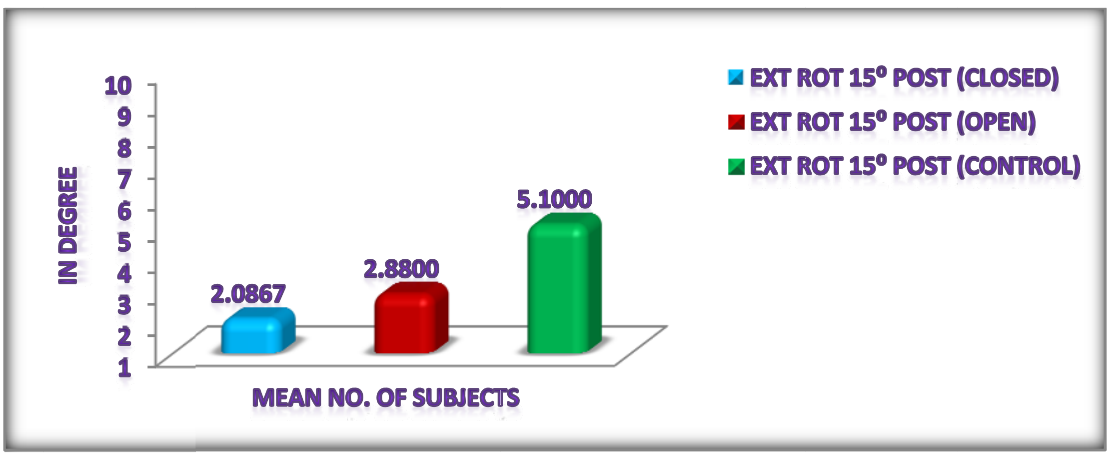
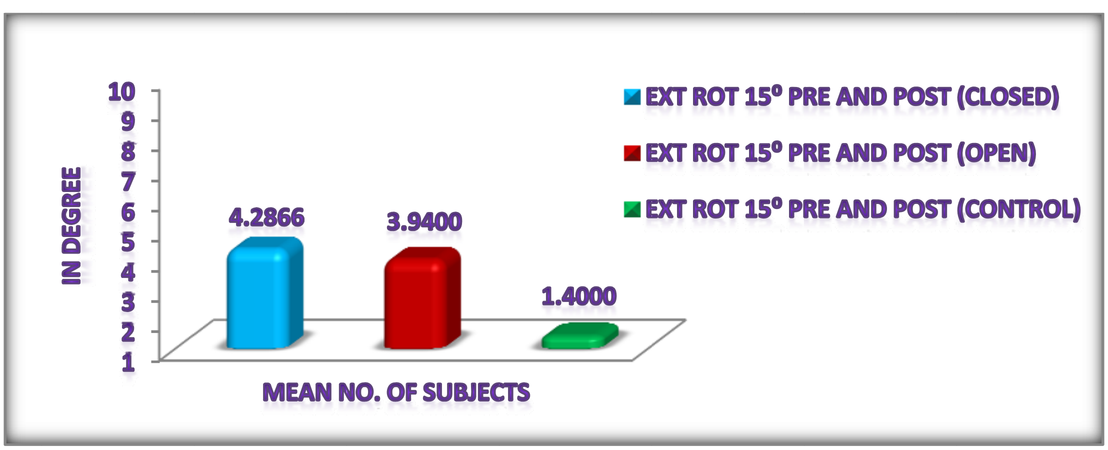


Fig 5.30 Comparison of mean improvement at 15^0 of external rotation



5.2.9 PRE TEST 30^0 EXTERNAL ROTATION

Source of variation	Sum of squares (SS)	Degrees of freedom	Mean squares (MS)	Calculated F – ratio	Table F- ratio
Between samples	5.239	2	2.620	.517	4.98
Within samples	213.004	42	5.072		

5.2.10 POST TEST 30^0 EXTERNAL ROTATION

Source of variation	Sum of squares (SS)	Degrees of freedom	Mean squares (MS)	Calculated F – ratio	Table F- ratio
Between Samples	164.069	2	82.035	58.926	4.98
Within samples	58.471	42	1.392		

Fig 5.31 Mean pre-test values of groups A, B, and C at 30^0 of external rotation

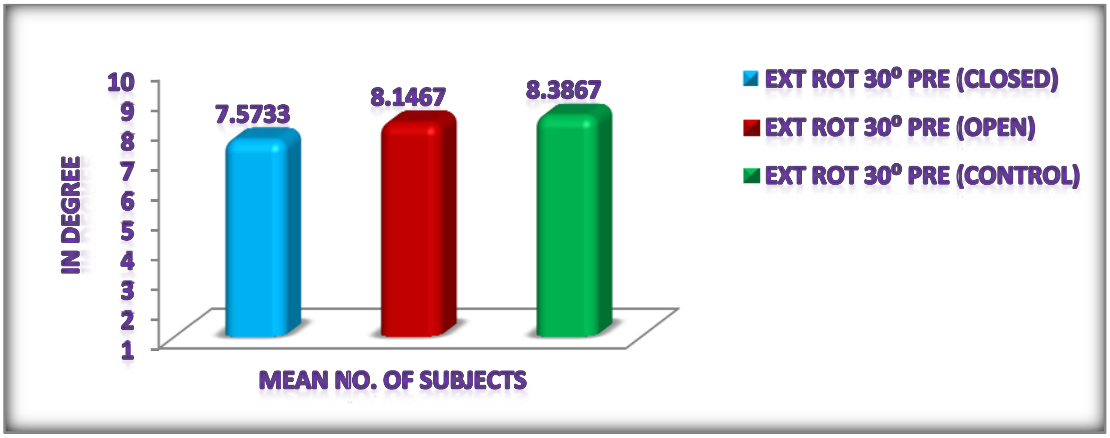


Fig 5.32Mean post test values of groups A, B, and C at 30^0 of external rotation

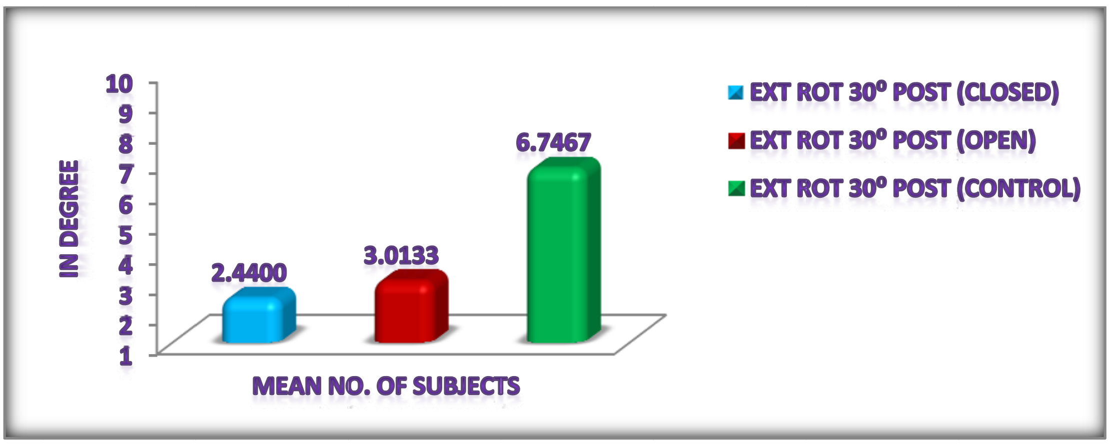
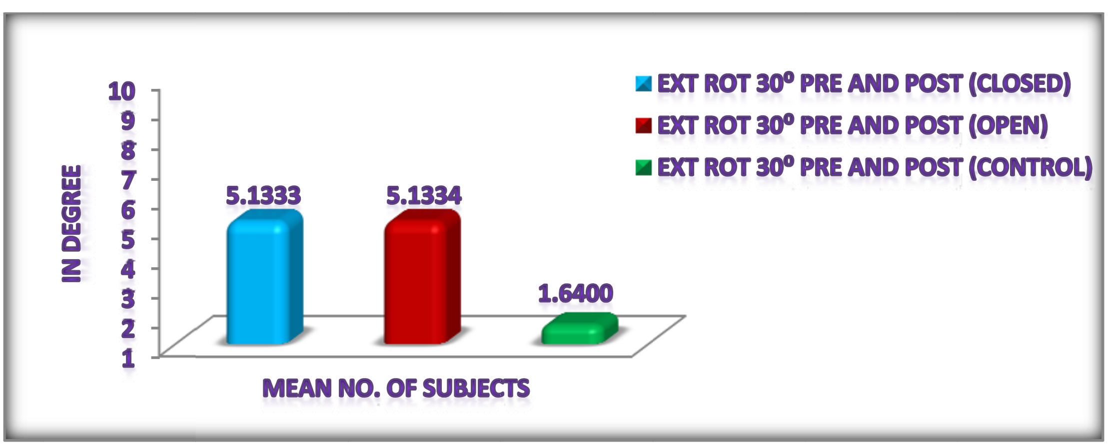


Fig 5.33 Comparison of mean improvement at 30^0 of external rotation



5.2.11PRE TEST 45^0 EXTERNAL ROTATION

Source of variation	Sum of squares (SS)	Degrees of freedom	Mean squares (MS)	Calculated F – ratio	Table F- ratio
Between Samples	49.084	2	24.542	1.98	4.98
Within samples	163.064	42	3.882		

5.2.12POST TEST 45^0 EXTERNAL ROTATION

Source of variation	Sum of squares (SS)	Degrees of freedom	Mean squares (MS)	Calculated F – ratio	Table F- ratio
Between samples	116.641	2	58.321	42.800	4.98
Within samples	57.231	42	1.363		

Fig 5.34 Mean pre-test values of groups A, B, and C at 45^0 of external rotation

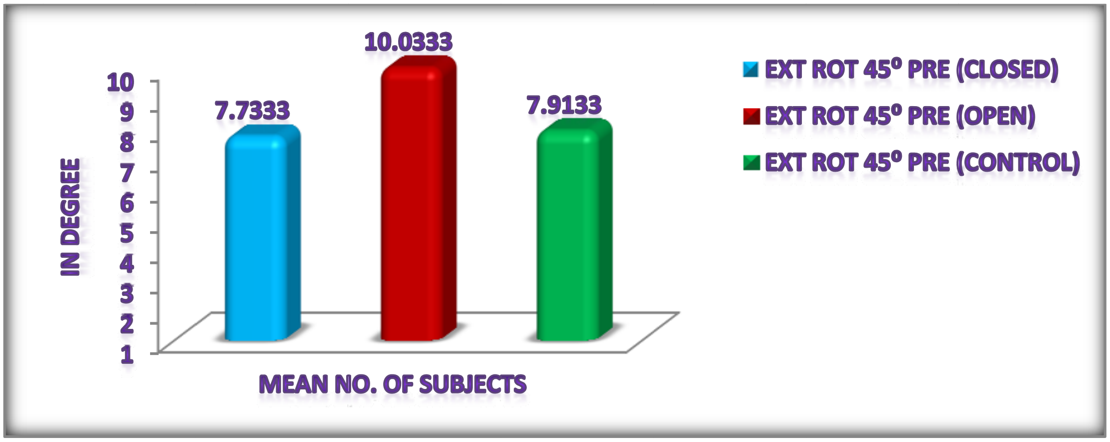


Fig 5.35Mean posttest values of groups A, B, and C at 45^0 of external rotation

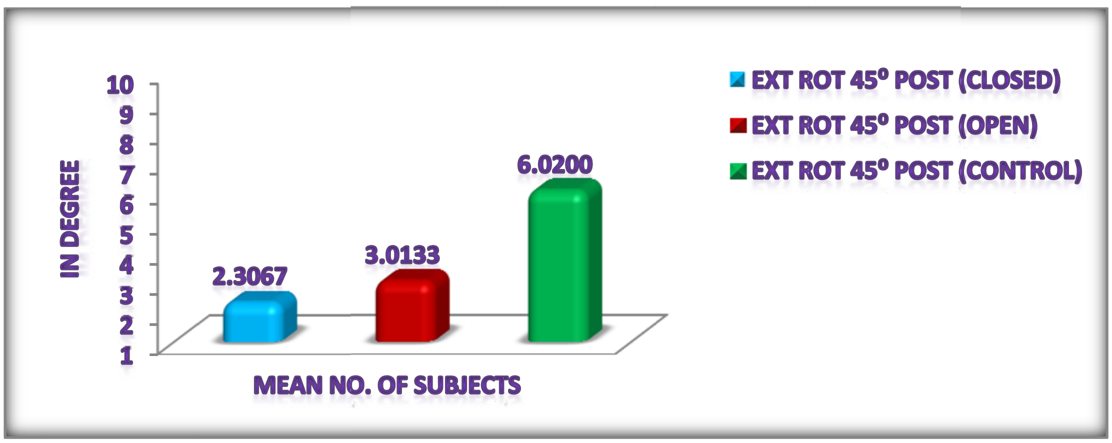
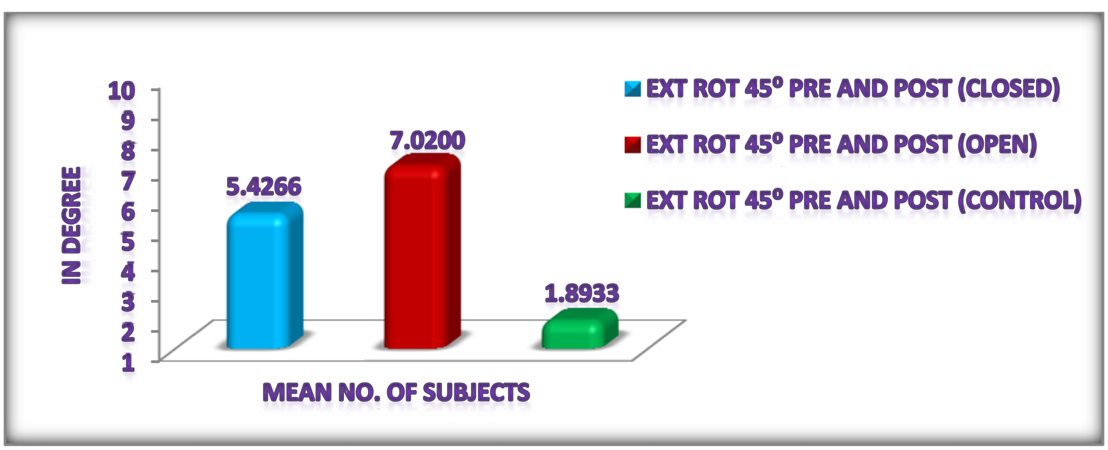


Fig 5.36 Comparison of mean improvement at 45^0 of external rotation



DATA ANALYSIS AND INTERPRETATION

6. DATA ANALYSIS AND INTERPRETATION

6.1 PAIRED ‘t’ TEST

CLOSED KINEMATIC GROUP

6.1.1 Paired t- test at 15^0 internal rotation

Paired ‘t’ test at 15^0 of internal rotation for closed kinematic chain exercise group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 10.742, since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

6.1.2 Paired t- test at 30^0 internal rotation

Paired ‘t’ test at 30^0 of internal rotation for closed kinematic chain exercise group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 9.446, since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

6.1.3 Paired t- test at 45^0 internal rotation

Paired ‘t’ test at 45^0 of internal rotation for closed kinematic chain exercise group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is11.455 , since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

6.1.4 Paired t- test at 15^0 external rotation

Paired ‘t’ test at 15^0 of external rotation for closed kinematic chain exercise group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 9.937 , since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

6.1.5 Paired t- test at 30^0 external rotation

Paired ‘t’ test at 30^0 of external rotation for closed kinematic chain exercise group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 9.609 , since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

6.1.6 Paired t- test at 45^0 external rotation

Paired ‘t’ test at 45^0 of external rotation for closed kinematic chain exercise group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 11.963 , since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

OPEN KINEMATIC GROUP

6.1.7 Paired t- test at 15^0 internal rotation

Paired ‘t’ test at 15^0 of internal rotation for open kinematic chain exercise group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 14.838, since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test and the null hypothesis is rejected.

6.1.8Paired t- test at 30^0 internal rotation

Paired ‘t’ test at 30^0 of internal rotation for open kinematic chain exercise group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 7.450, since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

6.1.9Paired t- test at 45^0 internal rotation

Paired ‘t’ test at 45^0 of internal rotation for open kinematic chain exercise group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 10.905, since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

6.1.10 Paired t- test at 15^0 external rotation

Paired ‘t’ test at 15^0 of external rotation for open kinematic chain exercise group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 10.428 , since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

6.1.11 Paired t- test at 30^0 external rotation

Paired ‘t’ test at 15^0 of external rotation for open kinematic chain exercise group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 7.265 , since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

6.1.12 Paired t- test at 45^0 external rotation for open kinematic group

Paired ‘t’ test at 15^0 of external rotation for open kinematic chain exercise group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 16.805 , since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

CONTROL GROUP

6.1.13 Paired t- test at 15^0 internal rotation

Paired ‘t’ test at 15^0 of 1nternal rotation for control group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 9.191, since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

6.1.14Paired t- test at 30^0 internal rotation

Paired ‘t’ test at 15^0 of 1nternal rotation for control group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 4.789, since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

6.1.15 Paired t- test at 45^0 internal rotation

Paired ‘t’ test at 15^0 of 1nternal rotation for control group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 4.801, since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

6.1.16 Paired t- test at 15^0 external rotation

Paired ‘t’ test at 15^0 of external rotation for control group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 4.692, since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

6.1.17 Paired t- test at 30^0 external rotation

Paired ‘t’ test at 30^0 of external rotation for control group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 7.696, since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

6.1.18 Paired t- test at 45^0 external rotation

Paired ‘t’ test at 45^0 of external rotation for control group was done at 5%level of significance for 14 degrees of freedom, the table value is 2.145 and the calculated value is 9.659, since calculated ‘t’ value is greater than the table ‘t’ value there is a significant difference between pre and post test values and the null hypothesis is rejected.

6.2 ANOVA

6.2.1 PRE TEST 15^0 INTERNAL ROTATION

The normal F value for 2 and 42 degrees of freedom was 4.98. The calculated value was .065. Since the calculated value was less than the table value, the null hypothesis is accepted. Hence there was no significant difference in pre test values between the three groups.

6.2.2 POST TEST 15^0 INTERNAL ROTATION

The normal F value for 2 and 42 degrees of freedom was 4.98. The calculated value was .49.783. Since the calculated value was more than the table value, the null hypothesis is rejected. Hence there was a significant difference in post test values between the three groups.

6.2.3 COMPARISON OF MEAN IMPROVEMENT

With the above graph it is clear that there is a decrease in reposition error scores in closed kinematic chain exercise group when compared to control group which has a mean difference score of 1.7133.There is a difference in mean error scores of 0.4467between closed kinematic chain exercise group 4.3933 and open kinematic chain exercise group 3.9466 respectively. So it is concluded that closed kinematic chain exercise group improves joint position sense at 15^0 of internal rotation when compared to open kinematic chain exercise group and control group.

6.2.4 PRE TEST 30^0 INTERNAL ROTATION

The normal F value for 2 and 42 degrees of freedom was 4.98. The calculated value was .419. Since the calculated value was less than the table value, the null hypothesis is accepted. Hence there was no significant difference in pre test values between the three groups.

6.2.5 POST TEST 30^0 INTERNAL ROTATION

The normal F value for 2 and 42 degrees of freedom was 4.98. The calculated value was 87.023. Since the calculated value was more than the table value, the null hypothesis is rejected. Hence there was a significant difference in post test values between the three groups.

6.2.6 COMPARISON OF MEAN IMPROVEMENT

With the above graph it is clear that there is a decrease in reposition error scores in closed kinematic chain exercise group when compared to control group which has a mean difference score of 1.4000.There is a difference in mean error scores of 0.3466 between closed kinematic chain exercise group 4.2866 and open kinematic chain exercise group 3.9400 respectively. So it is concluded that closed kinematic chain exercise group improves joint position sense at 30^0 of internal rotation when compared to open kinematic chain exercise group and control group.

6.2.7 PRE TEST 45^0 INTERNAL ROTATION

The normal F value for 2 and 42 degrees of freedom was 4.98. The calculated value was .144. Since the calculated value was less than the table value, the null hypothesis is accepted. Hence there was no significant difference in pre test values between the three groups.

6.2.8POST TEST 45^0 INTERNAL ROTATION

The normal F value for 2 and 42 degrees of freedom was 4.98. The calculated value was 54.944. Since the calculated value was more than the table value, the null hypothesis is rejected. Hence there was a significant difference in post test values between the three groups.

6.2.9 COMPARISON OF MEAN IMPROVEMENT

With the above graph it is clear that there is a decrease in reposition error scores in closed kinematic chain exercise group when compared to control group which has a mean difference score of 1.9266.There is a difference in mean error scores of 0.2467 between closed kinematic chain exercise group 5.3867 and open kinematic chain exercise group 5.1400 respectively. So it is concluded that closed kinematic chain exercise group improves joint position sense at 45^0 of internal rotation when compared to open kinematic chain exercise group and control group.

6.2.10 PRE TEST 15^0 EXTERNAL ROTATION

The normal F value for 2 and 42 degrees of freedom was 4.98. The calculated value was .302. Since the calculated value was less than the table value, the null hypothesis is accepted. Hence there was no significant difference in pre test values between the three groups.

6.2.11POST TEST 15^0 EXTERNAL ROTATION

The normal F value for 2 and 42 degrees of freedom was 4.98. The calculated value was 32.659. Since the calculated value was more than the table value, the null hypothesis is rejected. Hence there was a significant difference in post test values between the three groups.

6.2.12 COMPARISON OF MEAN IMPROVEMENT

With the above graph it is clear that there is a decrease in reposition error scores in closed kinematic chain exercise group when compared to control group which has a mean difference score of 1.6400.There is a difference in mean error scores of 0.0001 between open kinematic chain exercise group 5.1333 and closed kinematic chain exercise group 5.1334 respectively. So it is concluded that open kinematic chain exercise group and closed kinematic chain exercise group are equally effective in improving joint position sense at 15^0 of external rotation when compared to control group.

6.2.13 PRE TEST 30^0 EXTERNAL ROTATION

The normal F value for 2 and 42 degrees of freedom was 4.98. The calculated value was .517. Since the calculated value was less than the table value, the null hypothesis is accepted. Hence there was no significant difference in pre test values between the three groups.

6.2.14 POST TEST 30^0 EXTERNAL ROTATION

The normal F value for 2 and 42 degrees of freedom was 4.98. The calculated value was 58.926. Since the calculated value was more than the table value, the null hypothesis is rejected. Hence there was a significant difference in post test values between the three groups.

6.2.15 COMPARISON OF MEAN IMPROVEMENT

With the above graph it is clear that there is a decrease in reposition error scores in closed kinematic chain exercise group when compared to control group which has a mean difference score of 1.0400.There is a difference in mean error scores of 0. 9733between closed kinematic chain exercise group 4.4533 and open kinematic chain exercise group 3.4800 respectively. So it is concluded that closed kinematic chain exercise group improves joint position sense at 30^0 of external rotation when compared to open kinematic chain exercise group and control group.

6.2.16 PRE TEST 45^0 EXTERNAL ROTATION

The normal F value for 2 and 42 degrees of freedom was 4.98. The calculated value was 1.98. Since the calculated value was less than the table value, the null hypothesis is accepted. Hence there was no significant difference in pre test values between the three groups.

6.2.17 POST TEST 45^0 EXTERNAL ROTATION

The normal F value for 2 and 42 degrees of freedom was 4.98. The calculated value was 42.800. Since the calculated value was more than the table value, the null hypothesis is rejected. Hence there was a significant difference in post test values between the three groups.

6.2.18 COMPARISON OF MEAN IMPROVEMENT

With the above graph it is clear that there is a decrease in reposition error scores in open kinematic chain exercise group when compared to control group which has a mean difference score of 1.8933.There is a difference in mean error scores of 1.5934 between open kinematic chain exercise group 7.0200 and closed kinematic chain exercise group 5.4266 respectively. So it is concluded that open kinematic chain exercise group improves joint position sense at 45^0 of external rotation when compared to closed kinematic chain exercise group and control group.

DISCUSSION

7. DISCUSSION

During the past few decades, joint position senses in athletes have received much attention in the scientific and clinical literature. Researchers are investigating about the joint position sense in shoulder joint in different criterion positions for improving the overall athletes performance.

The primary finding in this study was that the closed kinematic chain exercise group had significantly improved the glenohumeral joint position sense in all the criterion positions except at the 45^0 of external rotation from pretests to posttests when compared with the open kinematic chain exercise group and control group. The findings also suggest that there is no statistically significant difference between closed kinematic chain and open kinematic chain exercise groups.

In closed kinetic chain exercise, the distal segment of the extremity is fixed, and proximal motion takes place in multiple planes. Closed kinetic chain exercise is thought to establish early proximal stability of the joint, providing a stable base for the upper extremity to function. A short fall of closed kinematic chain exercise is that minimal acceleration of the distal extremity is allowed, and this is a key component of upper extremity athletic performance.

In open kinetic chain exercise, the terminal segment of the extremity moves freely without any external resistance. The sequential activation of muscles in open kinematic chain exercise is from proximal to distal allows rapid acceleration and speed of the distal segment. Because the upper extremity often functions in an open kinematic chain position, this type of exercise is frequently used

Both the groups were able to reposition the target angles and had a better awareness of the location of their upper extremity in space in comparison with the control group.

Control group doesn’t show any statically significant effect in the improvement of glenohumeral joint position sense. It is believed that the muscle spindles are regarded as important contributors to proprioceptive acuity. Therefore it is believed that stretching alone did not appreciably change the spindle firing characteristics.

The mechanism for the improvement of glenohumeral joint position sense in this study was due to the additional stimulation of the joint and muscle receptors brought about by the closed and open kinematic chain exercise. Receptors responsible for detecting joint position includes the Pacinian corpuscles and Ruffini end-organs found in the joint capsule and the Golgi tendon organs and muscle spindles found in the muscle. All these receptors are sensitive to changes in tension within the muscle (Golgi tendon organs and spindles) or non contractile tissues (Pacinian corpuscles and Ruffnii end-organs).

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SUMMARY & CONCLUSION

8. SUMMARY AND CONCLUSION

An effort was put in this study to find out the effect of closed kinematic chain exercises with open kinematic chain exercises in improving glenohumeral joint position sense. Subjects were intercollegiate cricket fast bowlers referred by the coaches of their respective colleges. Forty five subjects were taken for the study and allotted into three groups. The three groups are closed kinematic chain exercise group, open kinematic chain exercise group and the control group. All the subjects were screened for any contraindications. The outcome measure taken for the study is Glenohumeral joint position sense. The different criterion positions assessed were 15, 30 and 45 degrees of internal rotation and 15, 30and 45 degrees of external rotation.

The outcomes of the study were taken on the first day and after six weeks. The treatment was given for five days a week for a total of six weeks. Subjects are advised not to indulge in other activities other than the given exercise protocol. The joint position sense assessment was done by the inclinometer. The statistical analysis was done using paired ‘t’ test at 5% level of significance and one way ANOVA. The result shows that there was a significant difference between the experimental and control groups.

In comparison between the closed kinematic chain exercise group and open kinematic chain exercise group, there is no statistically significant difference between closed and open kinematic chain exercise group.

By my above experiment it is stated that closed kinematic chain exercises and open kinematic chain exercises can be given to the cricket fast bowlers. It is believed that open and closed kinematic chain exercises improves the glenohumeral joint position sense by additional stimulation of the joint and muscle receptors.

The findings in this study suggest that shoulder joint position sense can be enhanced with six weeks of training in healthy cricket fast bowlers and also closed and open kinetic chain exercises appear to be equally effective in improving shoulder joint reposition sense.

So it is concluded that both the closed kinematic chain exercises and open kinematic chain exercises can be given to the athletes to improve the glenohumeral joint position sense and thereby to prevent the injuries.

Therefore it is recommended that closed kinematic chain exercises and open kinematic chain exercises can be included in the athletes regular practice along with their routine conventional practices to improve the glenohumeral joint position sense and improve their throwing performance and their by reducing the risk of injuries.

LIMITATIONS & SUGGESTIONS

9. LIMITATIONS AND SUGGESTIONS

- Short term effects are only assessed, it is suggested that long term effects should be analysed.
- Group size was smaller hence further studies has to be done with more samples.
- Similar studies can be done for shoulder injured athletes.
- Only fast bowlers are taken in this study, so in future medium pace bowlers and fielders can be taken.
- Further research is required to determine shoulder position sense in other shoulder movement components like flexion, abduction.
- Future studies can be done with different criterion positions and see the effect.
- Future studies can be done with isokinetic dynamometer to assess the joint position sense.

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APPENDIX

APPENDIX I

INFORMED CONSENT TO PARTICIPATE IN THE RESEARCH STUDY

I ___________________ voluntarily consent to participate in the research study

"COMPARISION OF THE EFFECT OF OPEN KINEMATIC CHAIN EXERCISES WITH CLOSED KINEMATIC CHAIN EXERCISES IN IMPROVING THE GLENOHUMERAL JOINT POSITION SENSE IN MALE CRICKET FAST BOWLERS"

The researcher has explained to me about the exercise approach in brief, the risk of participation and has answered the questions related to the research to my satisfaction

Signature of the applicant: **Signature of the researcher:**

Signature of the witness:

APPENDIX 2

Assessment form

NAME: CONTACT NUMBER: HANDEDNESS: HEIGHT: WEIGHT: AGE:	INTERNAL ROTATION						EXTERNAL ROTATION					
	PRE TEST			POST TEST			PRE TEST			POST TEST		
	15˚	30˚	45˚	15˚	30˚	45˚	15˚	30˚	45˚	15˚	30˚	45˚
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